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MAN'S FOODS

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Nutrition and Environments in Food Gathering Times and Food Producing Times

BY

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To

My Daughter

Roalda Jensen

This Book is

Affectionately Dedicated

PREFACE

The purpose of this book is to outline for the reader interested in foods an introductory survey of man's foods from the Paleolithic Epochs to the close of Classical Times and to indicate some of the nutritional influences of various foods on man's development. Among the readers whose vocational or professional interests have been kept in mind are food technologists, nutritionists, physicians, biochemists, home economists, dietitians, veterinarians, microbiologists, and students of agriculture.

The rapid advances of knowledge in the disciplines of nutritional science, archaeology, anthropology, genetics, and supporting sciences preclude dogmatic assertions about Man in his complexities. We may conclude, however, that Man is never an unchangeable entity.

It is possible that the new and hence intrusive science of nutrition may eventually prove to be an adhesive which can bind a few seemingly unrelated data of Man's evolution and history. Food is the one absolute need for Man. The history of Man perhaps could be written in terms of diet and the fulfilled promises of nutrition. The work outlined here does not accomplish that intricate and difficult task, but does point up as others have done the need for close group research in the several disciplines. The writer has devoted many years to the study and practices of microbiology and pathology, food technology and problems arising from large scale preparations and consumption of foods, but his fragmentary story of Man's Foods inherently possesses many defects and among these a common defect of history. History does not consist of a series of perfect analogies. This shortcoming pervades many fields which depend upon correlations and interrelationships. Data from ever-increasing tempo of research may also at any instant change our concepts in the several fields with kaleidoscopic abruptness. Thus our work may be likened to the footnotes of an anticipated story.

This book cannot supplant detailed technical papers which can appear only in technical journals. The references at the back of the book indicate some of the major highways over which the sciences have travelled.

While enrichment of man's diet and extension and increase of his food supply may have been due mainly to development of tools, intangible factors like curiosity are also involved. The digging stick and wooden spear were possibly a half-million years apart, but were much the same in shape. The stone mortars of food gathering times were used perhaps to grind pigments like red ocher and malachite for cosmetic

and ritual needs. More than has yet been invoked is needed to explain the rise of food production and civilization. We have not attempted to review with any completeness this important phase of the neolithic and the proto-literate periods. The technological transitions had defied recognition until very recently.

We have assumed that the spread of *food production* from the nuclear Near East functioned as a preparatory vector for the prelude of Western Civilization. The stream of civilization followed the spread of *food production* slowly and sometimes rapidly. This can be seen in the advances from the Iranian locus to Mesopotamia, and thence to Hittite Anatolia and on to Greece. The Hellenic World taught the Roman World, and eventually after some resistance, Western, Northern, and Central Europe became the delta of the broadening stream. Obviously, we are not historians and cannot deal with these main historical sequences. Likewise, we have not dealt with the collateral impacts of Egyptian, Palestinian, and Indian civilizations on history. The foodstuffs and the basic foundation foods of these periods, however, have been reviewed.

We have avoided the use of the emotional term, Race, in this book and have generally used the noncommittal phrases Ethnic groups or Ethnic units, which can be synonymized with "race" until human genetics furnishes us with diagnostic reagents clearly identifying specific traits of freely interbreeding mankind.

Religious and social products and the words which express them are not within the ambit of extended discussions here, although it is known that in time and space Man's spiritual and social needs and equipment set him apart long ago from the animals. Certainly, in historical time we may see civilizations based upon materialism consume their moral capital without means to renew it. Man does not live by bread (food) alone.

I am indebted to a host of workers in the many fields touched on in this book. The helpful criticisms of Harold S. Mitchell, Director, and Dr. E. E. Rice, Dr. F. W. Chornock, J. F. Beuk, and J. E. Sherman of the Research Laboratories of Swift & Company have prevented many inaccurate statements, but the errors of omission and commission are, of course, the sole responsibility of the author. The author gratefully recognizes the assistance of his wife, Frances McMahon Jensen, who assisted at every point in the formation of this book. Special acknowledgment is given to Mr. Robert J. Garrard, President; Mr. J. A. Chapman and Mrs. Lois Hough of The Garrard Press, for their constant interest and helpful advice.

LLOYD B. JENSEN

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FOOD-GATHERING TIMES

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CHAPTER I

Foods of Men of Pre-Chellean-Chellean

Dartians and Java Men

One of the stories in the curious book "Physiologus," put together in ancient Alexandria, tells how the lion as he runs brushes away his tracks with his tail, so that hunters may not track him. So too does Nature try to obliterate the records of Early Man with her erosions of time. Nature has not been a museum curator selecting fossils and artifacts for complete information, but has been careless of the feelings of the anthropologist and archaeologist. The lower Pleistocene world of Early Man has long since disappeared, its physiographical contours eroded or buried, and most of its animals and plants extinct or evolved.

The Pleistocene span of time, reckoned usually as just under a million years, saw at least five groups of higher primates—ape men, according to Dr. Raymond Dart (1948)[1] and Dr. Robert Broom (1949) —enter the anteroom of Man running on their hind feet and using their hands for wielding unfashioned implements. These "Dartians" were part human, but dressed in the garb of anthropoid apes. Present opinion, which may be wrong, does not place them in direct line of human ancestry and they appear to have shuffled off into obscurity. Dart's evidence from the breccia suggests that *Australopithecus prometheus* used fire and bone implements. Some of these South African fossil

[1] The titles of published works cited by authors' names in the text are listed under the authors' names in the References at the back of the book.

anthropoids or protohominids are supposed by Dr. Dart to have been flesh-eating, skull-cracking, bone-breaking apes, and Franz Weidenreich thought the *Australopithecinae* to be closer to man than any living fossil anthropoids known. Dr. Broom believes it probable they dug out moles and hares with some kind of implements and killed antelopes, small baboons, and conies (of the Bible) for food. Dr. Broom (1950) mentions that a large ape without adequate physical means of defense (strong canines and ability to climb) is, biologically speaking, an impossibility. The molars of the ape, man-ape, fossil man, and modern man form a nearly perfect morphological record, Gregory (1949).

About 60 years ago Dr. Eugene Dubois of Amsterdam, searching for man's ancestors in Java, found the famous *Pithecanthropus* skull, and up to World War II, von Koenigswald had added to the Java finds four adult skulls, some mandibles and thighbones, chopping tools and scrapers. The gigantic forms found in Java are more likely to be lateral dead ends than ancestors, R. R. Gates (1948).

While foods and feeding habits of earliest man have been equated with those of large modern apes, mainly from the character of fossil teeth, the evidence points clearly to an omnivorous diet. For example, the gorilla is a vegetarian by nature, but can easily take to a varied human diet. Gargantua had a moderate diet of vegetables, meat, eggs, and milk. William Howells (1944) in a note mentions a young gorilla who preferred tenderloin steaks to sirloin. It is a fact that primal man ate many lowly foods both from necessity and choice and his self-selection was sound. We list some nutritional values of grubs, insects, and the like (Table 1), which show at a glance that these remote beings, and modern primal men, as well, could eke out a sustaining diet. "Nut-eating" men, as the Ancient Greeks viewed savage outlanders, were well supplied with thiamin, riboflavin, niacin, and vitamins A and C in some nuts. Primal man in all epochs ate to repletion when food was abundant. When food was scarce, he tightened his waistband, if he wore one, and starved philosophically. This lack of foresight is distinctive of primitive man under all circumstances. Paying heed to the morrow marked the new man who was to appear long epochs afterwards. Modern man often tightens his belt or waistband by overeating.

Pre-Pleistocene Hominids (Eolithic Age)

Artifacts prior to the first Ice Age are called "eoliths" by a few archaeologists. Moir (1927, 1935) believes there were six eolithic stages represented in England dating from upper Miocene and Pliocene, and T. T. Paterson (1948) found split flint and stone artifacts which he

TABLE 1

Some Nutritional Values of Primal Man's Food[1]

Sample[2]	Thiamin µg./gm.	Riboflavin µg./gm.	Niacin µg./gm.	Pantothenate µg./gm.	Ascorbic Acid µg./gm.	Biotin µg./gm.	Inositol µg./gm.
Rat	5.0	10.5	180	38	present when fresh	0.33	560
Fish	9.5	5.2	78	24	present when fresh	0.31	850
Frog	6.4	11.4	53	17	present when fresh	0.57	1,230
Snake	5.1	4.5	142	25	present when fresh	0.25	1,070
Red ant	7.3	14.0	47	30	present when fresh	0.37	2,200
Cockroach	16.2	26.0	120	65	present when fresh	0.48	1,350
Oyster	11.0	14.0	75	35	present when fresh	0.50	2,800
Earthworm	7.8	30.0	48	9	present when fresh	0.25	500
Mushroom	8.8	26.0	550	140	present when fresh	1.50	1,400
Wet human muscle	1.2	2.0	50	12	present when fresh	0.04	500
Undried human brain	1.6	2.5	25	15	present when fresh	0.60	1,500
Slugs and grubs	8.0	30.0	50	10	present when fresh	0.30	900
Wheat seed (for comparison)	5.5	1.9	50	13	present when fresh	0.07	2,000

[1] Data supplied by J. F. Beuk and F. W. Chornock, personal communication.
[2] Whole organisms, dried weight.

dated pre-Pleistocene. Nothing definite is known about the foods of these early forms and we can for the moment dismiss them in this discussion after recalling, as L. A. White (1942) points out, that the essential difference between apes and men with regard to use of tools is not that men are more inventive, skillful, or versatile; nor is it in their ability to imitate, or to communicate tool experience from one to another. The fundamental difference lies in the fact that the use of tools among men is cumulative, and a progressive process; whereas, among apes it is neither, essentially because of the inability of apes to use symbols. Imaginative sense differentiates man from the lower animals.

Psychologists have shown that the chimpanzee species and humans are much more alike psychologically than supposed, and that man's ability to use language in the distant past may have been his only important genetical advantage, which obviously made further advantages possible since he could share knowledge of foods and tools. We shall see

that changes in the architecture of the face and skull brought about, broadly speaking, by nutrition and cookery were prime factors in man's evolution. The face became fashioned for its intricate task of communication by reduction of the chewing structures, and changes in the braincase gave the brain room for expansion.

The distinguished clinical nutritionist, Dr. J. S. McLester, long ago stated: "Ever since man's ancestors came out of the primordial sea and began groping about over the land for food, he has been able through eons to gain more control over food and to steadily improve the nature of his food—a potent factor in bringing man to his present position."

Since our purpose here is to view man's foods where the evidence is good, we shall enter into the province of the "digging" anthropologist and archaeologist sometimes openly and sometimes tacitly, using it as a quarry of ready-cut cores, flakes, and blades, and observe their finds of fossil men who fashioned them.

Peking Man (Sinanthropus)

The first assemblage of fossil man which yielded factual testimony about his foods and nutrition appeared in the Choukoutien fissure, situated in a hilly section about 37 English miles southwest of Peking, China. Near the village of Chou-Kou-Tien is a limestone hill—a veritable Pleistocene catacomb. The cave-site was found in 1923 by Dr. J. G. Andersson, the father of Chinese paleontology, who, after cursory investigation, remarked prophetically, "In this spot lies primitive man. All we have to do is to find him." The original cave was large—150 feet wide, east to west 525 feet, and 150 feet high. When discovered by Andersson, the cave was filled and was but a fissure in the limestone cliff. At this site, some 500,000 years ago during the Gunz-Mindel interglacial, according to Dr. F. E. Zeuner (1950), lived a type of man discovered by Dr. W. C. Pei and subsequently studied by Davidson Black, G. H. R. von Koenigswald, and Franz Weidenreich.

Sinanthropus pekinensis, as Peking man was first named, is now represented by fossil fragments of 38 individuals. His assemblage [2] found in the breccia cave material unfolded a clear chapter of the history of foods. Peking man used fire for cooking or roasting meat and ate the tissues of now extinct species of bison, horse, rhinoceros, flat-antlered deer (75 per cent of all bones found attest), brown bear, bighorn sheep,

[2] Dr. R. J. Braidwood's definition: "An assemblage includes all of the artifacts in every category of material and reflecting every possible type of human activity, which have context together . . . including any non-artifactual evidence of human activities." (Human Origins, Series II, 1946. Univ. of Chicago Press). Obviously, the ideal assemblage is not often found after the turmoil of Nature.

mammoth, camel, ostrich, antelope, water buffalo, wild boar, hyena, and otter. The charred bone fragments also show wolf, dingo, fox, large cats, two macaques, and one baboon. He cracked bones for red marrow and skulls for brains. He was cannibalistic, as were other paleanthropes and later species of man, as well. These early forms of man are often referred to as *hominids,* much like the designation *equids* was coined to denote horses and asses.

The *Sinanthropes* also ate large quantities of pea-size sweet hackberries in season. The modern hackberry, *Celtis,* numbers about 70 hardy species belonging to the elm family. *Celtis sinensis* of China now grows 30 feet high. *Celtis occidentalis,* called "nettle tree" and "sugar berry," bears oblong fruit about three-fourths of an inch long, dark purple in autumn, but red-yellow when young. The juice is very sweet (sucrose and hexoses) but slightly astringent. It is a good source of ascorbic acid (vitamin C). These trees vary from shrubs to trees 130 feet tall. (On semiarid stream borders hackberries are shrubs.) Hackberries were also eaten by Indians in western North America. Peking man crushed them, straining away the sweet juice, but obviously, lack of pots and pans precluded boiling the liquid with meats. The ashes of wood for his fires reveal that the same plants now exist there and elsewhere where the climate is somewhat cool and dry. He used quartz tools called "occasional tools" by V. Gordon Childe. Nearly 2,000 quartz artifacts have been found, scrapers and cutters made after the chopping tool tradition, or made on the spur of the moment for skinning and preparing animals for food. Ten stones not native to the cave were found, as well as pointed implements, hammerstones, and 25 animal bones showing traces of human workmanship.[3] All artifacts were crude and not at once accepted as fashioned by humans. Breuil (1939) has shown that besides the quartz industry, bone and antlers were utilized to a great extent, presumably because of the scarcity of suitable stone. In western Europe and Africa tools made by men at this time are found, but no fossil bones of the men who made them, unless Java (Trinil) man and Heidelberg man are contemporaries. Glaciated sites of man's early camps would certainly be obliterated for the most part in the ice advances and retreats which followed. However, a wooden spear of lower Paleolithic date[4] has been found at Clacton-on-Sea, Essex. Paleolithic man witnessed great oscillations of the ocean's surface. When sea levels

[3] Following the chopper-pebble tradition, the Ice Age tools of Europe are called flake tools, detached from a stone core. The core tools, like hand-axes, were made after the higher tradition of later times by carefully shaping a large lump of stone in about five standard forms. See Adrian Coates (1951).

[4] Chronologies of the Pleistocene are shown on page 12.

were low he settled on the shore along the fringes of river deltas. All such sites are now deeply submerged, thus handicapping the archaeologist who wants to know all about ancient man.

We may dwell briefly on the appearance and nature of *Sinanthropus* of half a million years ago. He retained certain osteological marks of the ape—prominent brow ridges, low-roofed skull, and receding forehead. Weindenreich found *Pithecanthropus*[5] of Java and his slightly advanced but close twin, *Sinanthropus*,[5] to be low-grade men. Of 38 fossil individuals, 15 were under 14 years of age, one 50 years old, and the remainder between 14 and 50 years. Their life expectancy was not more than 20 years. The grown males were five feet, one-and-one-half inches tall, and females four feet, eight-and-one-half inches. Sir Arthur Keith reckons their territory not more than two square miles per capita, and 100 individuals in the group would in a century replace a thousand new lives with a thousand deceased. At the end of a century they would have differed from the group at the beginning of the century.

Peking man of 500,000 years ago was undoubtedly capable of some speech but, as everyone knows, man did not learn to write until about 5,000 years ago. European fossil men (like the Neanderthal man), who are known to have lived not long after the Java-Peking group, were free to do very little. They must constantly be on the hunt for food. Modern students viewing primal man of all epochs conclude that the food drive, shelter, and sexual intercourse were his only proclivities. Both Sir Arthur Keith and Dr. N. Gras note that these early men, improvident of material things, careless of time, left a heritage which modern man after he grows well-off financially, emulates willingly: hunting in field and stream, northwoods and jungle; wine, women, and song. "Indeed, rich men seek relaxation by resuming the life of primal man."

The brain volume of Peking man ranged from 915 cc.—smaller than that of most modern men—to 1,225 cc., found in lower volumes of recent time. When *Sinanthropus* used fire and language, he was like a rough diamond emerging from the blue clay in which the precious stone is hidden. The countless years of slow improvements indicate also that he was hard to facet and polish. Paleolithic man, like the fauna of his time, was a parasite but was slowly imposing his will upon his environment. He was plastic, however, for the macaques and baboons found in the same locality do not differ from present forms except in size, which indicates that these forms had finished their specialization at a time when

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[5] The newer biosystematics have altered these taxonomic labels and lumped them together as *Homo erectus*.

the great skull and brain development was still to be experienced by man. While Weidenreich stated in 1947 that the facts available do not indicate that environmental conditions played a decisive role in the orthogenic course of human evolution, he did state in 1948 in his "Apes, Giants, and Men" that all fossil types of man discovered show characteristic features easily traced to modern man.

There was, however, a continuity in phylogenetic development. In studies showing the sequence, gorilla—*Sinanthropus*—modern man, in which brain-cases increased in size, the face became smaller. The reduction in jaws followed reduction of the chewing and cervical muscles. Erect posture influenced structural characters of the skeleton so that any fossil fragment is a signpost for reconstruction of the whole, although the skull and the patterns of the teeth are of the greatest importance. The differences in dentition and arch correlate closely with differences of skull shape and structure. The occipital crests and brow ridges of the anthropoids and earlier man were modified in modern humans by reduction of the chewing structures, and the brain-case and face also changed greatly. The heavy jaw and powerful musculature needed to snap such a jaw in mastication and biting, gave the brain in its thick and solid case little room for expansion. Until hands were shaped to grasp and manufacture tools or weapons, heavy jaws and cruel teeth were needed to fight and eat. With binocular vision kept in acuity with proper nutrition, and fine muscular coordination gained from a growing refinement of the brain, which in Peking man was already causing rudimentary swellings visible on his brain-case, speech began, with which parents educated their children. This progression prolonged childhood and made for family life and greater social units. Man was able to transmit experience by means of symbols, thereby interacting with his ancestors and descendants over periods of time. This mechanism of inheritable culture in the food quest was probably progressive at times and also static over long periods. Unfortunately, the shaman and leaders of primal men, like the modern demagogues with their false-to-fact orientations, could enslave a group in the sense of neurolinguistic reactions leading to food taboos, hostilities among groups, magic, and other uncritical or pathological behavior.

P. W. Schmidt (1949) and others show that the heavier chewing muscles come and go under environmental conditions, as an adaptation to tough and hard food, and may not be phylogenetic features. Hence, the most primitive man if living on soft foods would soon resemble recent *Homo sapiens* more than Peking man or Neanderthal. It has been noted that the form and external characters of the bones are affected by the

muscles attached to them. Dr. S. L. Washburn (1947) has shown experimentally that bones respond to the attached muscles and alter in a characteristic way. For instance, he has been able to modify the skull form of rats by severing various muscles in a way which seems to parallel evolutionary steps. Hence, the change from the pronounced brow ridges of earlier men to the smooth forehead of modern men may have resulted from a few drastic changes in the muscles of the head and neck. Morphology is the end result of different genes acting in a given environment. Selection may act on new phenotypes produced by dietary or other environmental factors. In short, the face and skull change markedly from the masticatory structural development. Dr. C. S. Coon (1948) states that cooking food is one of the prime causative factors in human evolution. There is no clear record of humans before they knew the use of fire.

The environmental school has believed that cooked foods (which we shall discuss in detail later) reduce the work of the jaws and teeth and change facial structure as well as the shape of the skull. The "bite" of the snapping modern adult jaw shows a pressure of 60 to 120 pounds or more. The muscular jaws of the pre-*sapiens* men must have been very strong indeed! Tooth enamel is the hardest substance found in the body. It gives sparks with steel, Maximow and Bloom (1930). Dr. C. S. Coon (1948) believes that, just as the habit of erect posture and walking on two legs alone freed the hands for all of their delicate skills, so the use of fire for cookery of flesh freed the face for its intricate task of communication. With skill and cleverness the needful goals for survival, the brain grew.

Later Inhabitants of the Choukoutien Cave

Before leaving the cave-site of Chou-Kou-Tien, the lower site which we have seen, it may be of interest to note here that the cave ceiling fell in long after occupation by the *Sinanthropes*. An upper cave separated by vast periods of time from the Gunz-Mindel interglacial was inhabited by an upper Paleolithic folk contemporary with the Aurignacians of Europe (p. 21). While the upper site may have been a burial place (skulls show blow injuries), the deposits contained fossil skeletons of two men, two women, one youth, and two children. According to Weidenreich these skulls represent different types of modern man *(Homo sapiens)*. One is Mongolian, one is Melanesoid, and a third is Eskimoid, indicating that these early Asiatics already showed differentiation. There is some connection, too, with *Sinanthropus* and these later folk who evolved in Sino-Asia. Some *Sinanthropus* characters,

notably the lower jaws and "shovel"-shaped lateral incisor teeth, passed on by inheritance to Japanese, Chinese, Lapps, Eskimo, Amerinds, and Mongolians. The supraorbital ridges or brow ridges are still found well developed from China to Java and in some Amerinds as well as a few Europeans. Some orthodontologists hold that tooth reduction and civilization go together, probably the result of nutritional influences and mastication. Teeth and jaws not used for heavy work seem to reduce in size. On the other hand, Hooton (1918) observed that there appears to be rapid enlargement of masticatory muscles under subarctic conditions, as evidenced in the Medieval Icelanders long after their settlement. We shall delve deeper into this problem (p. 171).

These later Asiatics used many bone and stone implements and ornaments. Their food supply was furnished by the terminal Pleistocene fauna as the fossilized bones show—cave bear, hyena, and thousands of bones of deer, tiger, hare, and ostrich. The bulk of the mammalian fauna of the upper cave appears to have evolved between the early and middle Pleistocene and these animals are still living in North China, Manchuria, and Mongolia, Wen-Chung Pei (1940).

CHAPTER II

Non-Sapiens Men of the Old Stone Age

Phases of the Past

When the continuum of human history and pre-history was paroled by Church and State,[1] there grew slowly at first, and rapidly the past hundred years, a new and changing concept of history and pre-history, so clearly described for the student in an excellent book by the English archaeologist, Glyn E. Daniel (1950).

The "three-age" system of man's history, devised a century ago in Copenhagen by Nyerup, Vedel-Simonsen, C. J. Thomsen, and Worsaae, with major credit to Thomsen, was an outgrowth of the classification of antiquities in the Danish National Museum. As the Danish Museum authorities in the early 1800's noted, there were in Denmark only Heathen and Catholic times, and Heathen times bore no labels. The cornerstone of modern archaeology was laid by Thomsen on the basis of industry and economics, dividing the artifacts and relics between Stone, Bronze, and Iron Ages. The sequence of these ages has not been shaken, but most archaeologists and anthropologists have refined the sequence in terms fitting the newer knowledge. For our purpose, *Food-Gathering* times and *Food-Producing* times serve to demarcate satisfactorily man's past economics. W. J. Perry (1923) and V. Gordon Childe (1925) applied the term *Food Gatherers* to the pre-agricultural folk, and *Food Producers* to those who devised and practiced agriculture, thus increasing the source of animal and vegetable foods, beginning some 7,000 years ago.[2]

The terminology of pre-history often approaches logomachy, and absolute chronologies of the Pleistocene [3] are still speculative. However, the regular decay of radioactive isotopes provides evidence of the age

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[1] Archbishop John Ussher (1581-1656), and Dr. John Lightfoot, Chancellor of the University of Cambridge, who refined the Archbishop's chronology, calculated that Man was created by the Trinity precisely at 9:00 a.m. (Greenwich mean time), Sunday, October 23, 4004 B.C., and by sundown the first weekend had created all animals and man—nothing being said about the apple tree and fig leaf.

[2] Elliot Smith, in his "Human History" ([1929], W. W. Norton & Co., Inc., New York, p. 180), accredits Dr. W. J. Perry (1923) with introduction of these criteria. V. Gordon Childe (1951), in the first edition (1925) of his "Dawn of European Civilization," selected *food production* as distinguishing the Neolithic from the earlier Paleolithic and Mesolithic.

[3] Pleistocene is a Greek word meaning "most of the new," and "new" refers to mammals, an unprecedented number of them.

not only of the earth itself but of pre-Cambrian rocks, Pleistocene sediments, and certain Neolithic materials of biological origin. The radioactive isotope thorium 230 with half-life of *circa* 83,000 years as a clock will aid in chronologies of the Pleistocene, and the First Glacial can now be placed at 1.1 million years. The recent discovery of W. F. Libby, and James Arnold (1950, 1951, 1952) of the University of Chicago, indicates that radioactive isotope carbon 14 with a half-life of 5,700 years (5568 ± 30 years) furnishes a clock up to about 25,000 years. Perhaps potassium 40 may be used in the future.

Dr. W. M. Smart (1951) calls attention to the possibility that the spontaneous disintegration of radioactive elements is related in some way to the action of cosmic rays and, if so, the rate of disintegration may vary from century to century according to the intensity of the rays. This is by way of example how new facts might change our firm conclusions, with far-reaching possibilities. However, Dr. W. F. Libby (1952) has evidence to show that cosmic-ray intensity has remained essentially constant for the last 5,000-10,000 years.

Pollen analysis as a method of dating owes its modern form to the Swedish geologist, Lennart von Post. The vast majority of pollen grains from trees and other plants is carried in the air and gradually sinks to rest in lakes, land, oceans, and snowfields. Anaerobic peat bogs may preserve the grains. Thus the vegetation and climates can be ascertained by pollen analysis of strata in a site. For instance, it can be shown that the North Sea basin was dry during the Mesolithic. Fire clearances of oak, hazel, birch, and alder for fields in Denmark, Iversen (1941), can be demonstrated in the Neolithic, and cereal pollen soon is evident. Dr. Iversen (1949) also proved that during the warm, dry subboreal period cereals were introduced into Scandinavia. For instance, the now sandy heaths of Jutland were continuous and dense birch-oak forests until the Iron Age. Von Post pictured global dating by extension of this method, H. Godwin (1951).

Before precise data revealed by the radioactive time clocks and other methods of dating the past will be available to us, we may follow a composite scheme of dating and of Stages, Culture, and Geology adapted from Zeuner, Childe, Flint, and others. In Table 2, which requires no direct comment, a general concept of the periods and cultures of the past may be formed. *Sinanthropus* and Java man are considered to have lived during Interglacial I, and before. The Dartians of South Africa are conjectured to have lived in the late Pliocene.

There were at least four distinct glacial periods during the Pleistocene period. Ice caps that lay over northwestern Europe and North America

TABLE 2

Dating the Past

Years	Geological period	Archaeological culture	Stage
0	Recent (see Tables 3, 5)	(See Tables 5, 6)	Mesolithic
50,000	Ice Age Wurm	Magdalenian Gravettian	Upper Paleolithic
100,000		Mousterian	Middle Paleolithic
150,000	Interglacial III. Warm-wet	Levalloisian	
200,000	Ice Age		
250,000	Riss	Clactonian	
300,000			
400,000	Interglacial II. Cold-dry	Chelleo-Acheulian	Lower Paleolithic
450,000	Ice Age Mindel		
500,000			
550,000	Interglacial Warm-wet I.		
600,000	Ice Age Gunz Pliocene		Eolithic

had maximum thicknesses of 6,000 to 10,000 feet. Under these huge loads the earth's crust was depressed as much as 1,000 feet in Europe and nearly 2,000 feet in North America, Daly (1926, 1938). The fall of sea-level at the climax of the last Glacial Age in northwestern Europe measured about 300 feet. By the end of the Boreal phase of post-glacial time the sea had arisen 150 feet and the English Channel had come into existence. Pleistocene geography is not the only factor. Cycles of rainy, i.e., "pluvial," climate, watered the now dry Hither-Asiatic lands, possibly the Northern Sahara and other deserts of the world. The climates of northern Europe from the last glaciation to the present are shown (Table 3) and in Table 4 are indicated the comparative archaeological epochs and historical periods in more recent times.

There is a growing opinion among Russian geologists that the frozen ground extant in the northern regions of their Union became so after the Fourth Glacial, as the result of the change into the present climate. The permafrost in northern Siberia goes down to a maximum of 1100 feet. It is possible to assume from the evidence of fossil plants and

TABLE 3
Northern Europe

Years	Glacial stages	Climate	Dominant vegetation and animals
0		Sub-Atlantic (cool-moist)	Beech Oak diminishes
2,000		Sub-Boreal (warm-dry)	Pine, beech domesticated animals
4,000		Atlantic (warm-moist)	Oak, elm, lime wild pig, deer, dog, bear, elk, beaver
6,000		Boreal (warm-dry)	Hazel, little pine aurochs, bison, horse, elk, hare, pig
8,000	Bothnian	Pre-Boreal (cold)	Birch, pine, tundra reindeer, horse, bison, bear, beaver
10,000 12,000		Arctic	
	Scanian	Subarctic	Birch, pine reindeer
16,000	Danish		
18,000	Brandenburg	Arctic cold	Tundra plants, reindeer
20,000			

pollens of bogs that after the last glacial retreat the climate reached a maximum warmth about 5000 B. C., and with minor fluctuations has become cooler and more moist, down to the present. The climate of today is slightly cooler than that of 500 B. C. According to Scandinavian geologists, the climatic optimum, a dry, warm period of 2,000 years' duration, was too dry near the tropics.[4]

In labelling the evolving groups of man, we may follow the chronological series first proposed by Gabriel de Mortillet and modified by later data, based largely on discoveries of fossil man and his assemblages in Europe. Like other systems for pre-history, the Paleolithic cultures are being reclassified, but the sequence given here serves our immediate purposes. Dating is necessarily tentative.

In Europe, at least, early food-gathering men can be rather well grouped in the sequence Chellean, Acheulian, Mousterian, Aurignacian,

[4] The standard American work on glacial geology is Glacial Geology and the Pleistocene Epoch. R. F. Flint, 1947. John Wiley & Sons, Inc., New York. The classic work of Frederick E. Zeuner, Dating The Past: An Introduction to Geochronology, Second Edition, 1950 (Methuen & Co., London), provides the student with the necessary information on the Old World glaciations.

TABLE 4

Food-Gathering Times

1. Eolithic Age	
2. Old Stone Age[1]	
Lower Paleolithic Period	
(a) Pre-Chellean Epoch	
(b) Chellean Epoch	—Begins 500,000 years
(c) Acheulian Epoch	—Begins 400,000 years
Levalloisian-Clactonian	
(d) Mousterian (Neanderthal)	—Begins 100,000 years
Upper Paleolithic Period (*Homo sapiens* appears)	
(e) Aurignacian Epoch	—Begins 60,000 years
Solutrean Epoch	—Begins 45,000 years
Magdalenian Epoch	—Begins 35,000 years
3. Mesolithic Age	
(f) Azilian—Tardenoisian Epoch	—Begins 20,000 years
(g) Maglemosian Epoch	
(h) Kitchen-Midden, or Ertebolle Epoch	
(i) Campignian Epoch	
(j) Asturian Epoch	
Food-Producing Times	
4. New Stone Age—Neolithic Age	—Begins 7,000 years
5. The Age of Metals	
Copper	
Bronze	
Iron-Steel	

[1] J. Grahame D. Clark has described these Stone Age culture names as "the time honoured hash of French place-names, provincial in both space and time." (Antiquity, 1931, 518).

Solutrean, and Magdalenian. Zeuner (1950) calls attention to the dependence of cultures on climate and observes that in mild phases of the Pleistocene hand-axes were suitable for grubbing, Clactonian blades and scrapers used for wood-working, and during the Levalloisian-Mousterian of both mild and cold, the hunters devised cutting-flakes for hunting and cutting meat. The Acheulians were vegetable and grub gatherers, the Clactonians a forest people, and the Levalloisians and Mousterians hunters of the interglacial and glacial who had also retained some practices of their predecessors. At the present time we must remain content to associate early man with fauna and flora of his time. i.e., fossils of woolly rhinoceroses and hairy mammoths, which bespeak a harsh, cold climate belonging to a glacial time; while remains of warmth-loving animals, like the hippopotamus, clearly indicate an interglacial period in Europe. Finds of fossil species of the many animals of the Pleistocene often determine which glacial or interglacial period. Stratification, tools, raised or lowered beaches, varves, and other means are ingeniously employed by prehistorians of the several disciplines to indicate periods and culture stages. Naturally, there is room for much disagreement.

The Neanderthalians

The late Dr. Franz Weidenreich (1945), whom we may follow in these matters, finds the Paleoanthropes who stand between Java-Peking men and *Homo sapiens,* or modern men, homogenous enough to warrant their classification as Neanderthalians. The Neanderthalians can be separated generally into the most primitive Rhodesian men and, by gradual advancement, into the Skhul folk of Mt. Carmel, Palestine—the most advanced. During the long period of the Old Stone Age there was slow but unmistakable evolution, beginning with the Java-Peking groups and ending with modern man. Formerly many investigators believed that Neanderthaloid groups became entirely extinct. This is not the case, as everyone with discerning vision can see for himself. Racial or regional differentiations are clearly recognizable within the Neanderthalian group. Thus we all have some of their genes, a good heritage withal, from folk who endured during the long cold and warm eras of Pleistocene time, competing with fierce mammals quite as formidable to seemingly helpless man as the misuse of atomic energy in our era of unnecessary turmoil and greed. The activities and nutrition of early man are of far greater import for us than the careers of the unholy characters foisted upon children in their history classes. Sir Flinders Petrie claimed that archaeology gives a more truly liberal education than any other subject, as at present taught, and Dr. J. G. D. Clark [Antiquity (1943) 118] goes so far as to declare that to peoples of the world generally . . . Paleolithic man has more meaning than the Greeks!

Heidelberg man, the forerunner of Neanderthal man, left us 16 solidly rooted teeth in a mandible. He was a product of the Second Interglacial, and is the oldest definitely human fossil in Europe. The mandible and teeth were discovered October 21, 1907, at a depth of 80 feet below the surface near the Nepar River, Germany, under two thick layers of wind-formed loess and several stratifications of clay and sand. At this site also were fossil two-horned rhinoceroses, straight-tusked elephants, bears, deer, cats, aurochs, bison, lions, beavers, and two kinds of horses, showing a warm period before the Third Glaciation of 120,000 years or more, according to various time scales. The teeth of Heidelberg man were larger than those of modern man, but small for such a powerful jaw, and the canine teeth do not project above the tooth level. The teeth are like those to be expected in the coming Neanderthal groups. His terrain was meadow and forest. Use of fire is questionable but possible. He is presumed to have had some meaningful speech.

In the Neander Valley near Dusseldorf rises a Devonian limestone precipice in which is a double cave about 60 feet above the river. The

first Neanderthal fossil was found in 1857 in the loam of that cave floor. Dr. William King, an Irish anatomist, described the find as a new type of human, *Homo neanderthalensis.* Other finds of Paleoanthropes were made afterwards in Europe, and a few years previously a fossil skull of Neanderthal type had been found when blasting the north face of Gibraltar for battery emplacements. In 1886 two skeletons were found in the rock shelter of Spy in Belgium, with fossil remains of cave bear, mammoth, woolly rhinoceros, reindeer, bison, and deer, together with flint blades and points. In 1899 at Krapina, Jugo-Slavia, in a sandstone cave where the river Krapina flows about 90 feet below the cave, were found the remains of 20 fossil men, together with stone implements, rhinoceroses, bears, horses, pigs, cats, otters, and beavers. There were evidences of fire, and bone-breaking for marrow, as well as skull-cracking for brain. This Neanderthal group was cannibalistic. Another famous find, made by three French priests at La Chapelle-aux-Saints in a cave on the terraced Sourdoire River, revealed a fossil skeleton of a Neanderthaler in an actual burial, with "mortuary" protection of flat stones and skillfully worked flint tools. There were fossil animal remains of woolly rhinoceros, reindeer, hyena, pig or boar, bison, horse, and ibex. In France, finds of both sexes, ranging from 11 years of age to middle age were made at Le Moustier and other sites, also in Central Asia, North Africa, Italy, Belgium, Malta, Palestine, and Crimea, showing Neanderthals to be Eurasian in distribution.

The average height of males was five feet, four inches, and females four feet, three inches. They possessed thick bodies, sloping shoulders, short necks, long arms, heavy, short legs, flat feet, and big hands. The heads were large with sloping foreheads, pronounced supraorbital ridges, wide noses, projected faces almost chinless, very powerful jaws and tearing teeth, although the canine teeth did not project. While there are signs of his ape ancestry, he was more human than any forms that had appeared before.

The Neanderthalian lived for thousands of years and underwent great changes in his varied climates and habitats. Although large-brained, he possessed a small frontal lobe. His intelligence was above Sino-Java man and probably not much below some primal folk of today. In modern dress he would not have been a bad-looking prize fighter or wrestler. He used skin clothing. He fashioned flakes of flint and stone for points (for wood shafts?), utilizing the wonderful invention of pressure flaking. He left a great variety of tools made from stone, bone, and antlers. His culture is known as Mousterian, from the site at Le Moustier, France. This culture dominated Eurasia and Africa for hundreds of thousands of years until about 50,000 to 30,000 years ago—

a span of 400,000 years according to the long chronologies, or the older estimates. Neanderthaloids obviously were capable men to have survived through the slowly changing glacial and warmer periods with the tremendous changes of climates, flora, and fauna. During the warm Third Interglacial and all through the Fourth Glacial period, his food supply changed drastically in species and availability. The last Ice Age environment, about which most of the Mousterian culture is known, modified many great mammals to be cold-resistant. His food in Europe was largely of animal origin. He utilized flesh, marrow, brain, and visceral organs for food. The Neanderthalians of Gibraltar caught and ate many of the now extinct great auk birds and gathered large amounts of mussels and limpets.

In a report recently published, Dr. Charles Glen King, Scientific Director of the Nutrition Foundation, said: "Primitive man seldom had reason to be concerned about protein foods, aside from the problem of getting enough to eat. His conventional consumption of meat, fish, eggs, and shellfish furnished proteins of good quality. And by coincidence, the same attractive foods provided good sources of vitamins and minerals." Ershoff and McWilliams (1950) in experiments with white rats found that vitamin B_{12} which is plentiful in meats enabled the animals to withstand intense cold without retarding their growth and development.

There was no lack of essential nutrilites in primitive man's dietary, with the possible exception of vitamin D. Dr. H. W. Schultz (1946) believes that during the overcast of the Boreal periods Neanderthal man suffered extinction in those areas from lack of sunshine, or vitamin D. Long ages afterwards, however, the proto-Mongoloids who appear to have been ice-trapped in an open area in western Asia, evolved under stress of food and climate to meet their environment, albeit they must have been few in number and inbred, before their astonishing expansion.

While some authorities point up modern primal man as a social fossil providing data for understanding the collecting and hunting men of the Paleolithic, it is concluded by most authorities that contemporary primitives are not living under the same customs and beliefs as the Stone Age men. Study of the art and equipment of Bushmen of South Africa, the Central Australians, and Eskimo, indicate they get their food in much the same way as the Old Stone Age men of Europe. The technics today show us how our forebears—Neanderthaloids, Magdalenians, and Aurignacians—devised their tools, but the mental qualities of our modern savages have progressed a little in coping with their environment, as evidenced by their complicated rules for marriage and kinship, and their magic, totems, and spirits. Also, there have been periods when

present-day savages may have enjoyed a slightly higher culture. Obviously, the thoughts and mentality of Stone Age man have to be interpreted only in light of his material culture remains. Brogger (1940) and others show some reconstruction possible for late pre-history of Europe from folk cultures surviving up to the last century.

From the earliest record, we must assume that Paleoanthropes from the Lower Pleistocene used wooden weapons, since Peking man's assemblage shows he was a hunter of animals and a head-hunter, as well. He was not a strict vegetarian and pacifist as deMortillet once argued. The lowly *Sinanthropus* was a hunter, used fire, probably clubs and pointed sticks. The lowly Tasmanians devised spears which they could cast 60 yards with lethal accuracy. Upper Paleolithic man, north of Latitude 42° (north boundary of Turkey, Portugal, and Rome) in the treeless tundra, must necessarily have developed bone and antler weapons and tools. When stone artifacts appear, the prehistorians label such implements as points, burins, borers, and above all "scrapers." In this connection we recall Montelius, who said of Old Norse objects: "If you cannot determine its use exactly, call it a 'brooch.'"

The fundamental uses for implements in all Old Stone Age cultures were for digging roots, skinning and dressing carcasses, and for woodworking. The surprisingly varied artifacts probably intended for identical uses by widely separated groups show man's differences in temperament and even artistic tradition.

Hunger forced man to invent snares, to fish with various devices, to devise forked and pointed stick harpoons, hook, weir, and finally net. The discovery and use of rotenone plants of stupefaction which are not poisonous to man must have occurred very early.

At first man found himself in a real state of inferiority as compared with the big animals on which he hoped to feed, Renard (1929). He invented all sorts of lines, traps, and snares for animals he could not deal with directly. A grass-covered pit delivered to him an elephant, bear, or tiger which fell into it, disembowelling itself on the sharp stakes on the bottom. Traps of this sort are frequently seen in wall paintings or drawings in prehistoric caverns of a later time.

The Neanderthalians, with much of their tradition, seemed to disappear abruptly from Europe at the beginning of the last ice advance, but *Homo sapiens* types of modern men who appeared soon afterwards in Europe, Asia, Australia (Keilor skull), Africa, and Palestine were already differentiated into several distinct types or "varieties," as teachers of today maintain. These types were the very faintly negroid Grimaldi race, the tall rugged Cro-Magnon, and short Combe-Cappelle varieties or Brunn round-headed types exhibiting Neanderthaloid traits,

the Chancelade Eskimo type, and the upper cave types of Choukoutien. *Homo sapiens* had undoubtedly evolved early in the Pleistocene, but Dr. S. L. Washburn (1947) doubts any great age may be ascribed to the development of modern man.

Neanderthalians survived longer than any other types of man and this they did under both severe and mild climates. Their foods were largely proteins and fats, supplemented by vegetable foods like roots, shoots, berries, and nuts in season. Cereals were not available to them, but our modern Stone Age Eskimos show that a carnivorous diet is sustaining for primal man.

Cannibalism

Eating habits and habits of cleanliness and tidiness of Neanderthalians may not have been of high order, as we view the subject through bacteriological and esthetic glasses, but in all recorded history the "other peoples" are suspect. The early Spanish explorers of Central America and our southern coasts called all unfriendly Amerinds cannibals, since they were "pagans" and thus suspect. It is a melancholy fact to record that all races from the beginning to the present have been cannibals. The practice existed for a variety of reasons: hunger and famine, ridding tribes of useless members, prisoners of war, and absorbing virtues of the brave. In Tahiti an old Polynesian chief told the famous writer, Pierre Loti, "The white man well-roasted tastes like a ripe banana," but the Figians complained that whites as a rule were "poor eating," salty, and that "an old Nordic sailor was tough, hard, and scarcely edible!"

There have been modern apologists, notably M. Roberts (1920), and A. H. Keane (1920), who state in sequence, "Cannibalism has been a powerful factor of progress and human advance." "Here again in Africa the observation has been made that tribes most addicted to the practice also excel in mental qualities and physical energies, nor are they strangers to the finer feelings of human nature!"

While common sense does not extend to Reimann's geometry and Einstein's mathematical concepts, it does block out all but abhorrence of the practice of cannibalism. Whatever has raised man out of his animal ancestry and added to his intellectual and moral stature is controversial, but all of these unknown principles must have a common denominator which may be called humanistic. There is a large literature on this grisly subject, but suffice it to say that the only scientific virtue that comes to mind is that such "food" will not incite allergy, since homologous proteins are not antigenic for the same species.

The Neanderthalians and early *sapiens* men were not without a spiritual culture, about which much has been written, G. R. Levy (1948).

CHAPTER III

Homo Sapiens, Modern Man

Cro-Magnon Epochs and Foods

Modern man, bearing the bright label *Homo sapiens,* appeared suddenly in the person of the Cro-Magnon in Europe during upper Paleolithic time. If we knew the dates of the last glaciation we might fix his epoch. As these matters go, 30,000 to 60,000 years ago is a reasonable guess. The end of the upper Paleolithic in Europe began about 12,000 B. C. The Cro-Magnon group is generally accepted as Caucasian, or white, and its genetical stream has flowed into several European subraces, called Paleolithic survivors. There can be little doubt that these early modern men, wherever their sites of origin, absorbed some of the Neanderthaloid groups whenever they came in contact with them. The Mount Carmel group of Palestine and the Neanderthaloid child identified by Dr. Wilton Krogman, from the upper Paleolithic of Uzebekistan in Central Asia, represent an intermediate form between Neanderthalian and modern man. Since it is now clear to many anthropologists that Neanderthaloids and *Homo sapiens* interbred freely, they were at most subspecies of a single species of the genus *Homo.* In every group of early and present man, anthropologists find structural differences and behavior patterns of great variety. There were many evolutionary steps in all groups of man. Human forms preceding modern man differed as much among themselves as modern man. Fixations of ethnic types identified with modern man were probably accomplished before upper Paleolithic time, although great changes were to come. Further expansion of brain-case was at an end with the Neanderthalians. Heightening of the skull is the last evolutionary phase, with high degree of encephalization of the brain, the seat of the most human mentality. Round-headedness (brachycephaly) made its first appearance but in small numbers, in upper Paleolithic times. Today, most of the world's population is either brachycephalic or mesocephalic, except the Australian and African natives. These changes in head forms accelerated in Mesolithic and Neolithic times which followed, and today are phenomena of some importance (see pp. 173-175).

Some authorities assert that we can be reasonably certain that Neanthropic man (Cro-Magnon, fully modern man) evolved from Paleoanthropic man (the Neanderthalians). Cromagnard culture has now been divided into several epochs of upper Paleolithic time named

after the French sites of their discovery, the Aurignacian, Solutrean, and Magdalenian sequence, and these epochs have in turn been subdivided into cultures based mainly on tools of stone and bone.

Aurignacian

The Cro-Magnons were generally tall, robust-muscled folk, with large heads, but as variable as modern subraces within themselves. Many males stood six feet high. The recent long-headed folk of northwest and western Europe are their closest descendants. Some of the present inhabitants of the Dordogne possess many of the Cro-Magnon physical characteristics which may be due either to descent without much mixing, or to reëmergence. They possess a high frequency of Rh negative blood group factor. The European Aurignacian epoch with which the upper Paleolithic period began is represented in an early horizon by the two Grimaldi skeletons found in the Grotto des Enfants near Mentone, which we studied in 1919 at the Museum of the Prince of Monaco. The negroid character of one of the specimens was not subscribed to then, although it is possible that the adult female and the young male are ancestral to Negroes and Whites. These Grimaldians are said to be a component of the archaic "Caucasoid," which semantically is of little meaning. It is possible that an Aurignacian stock, contemporary with the Chatelperronian, during the first phase of the last glaciation, developed into the Grimaldi and continued to evolve from its ancestral stock in Italy and Sicily.

The Aurignacians fashioned stone implements with techniques differing little from the Mousterian, but their distinctiveness lay in the blade-like shapes and beak-pointed burins. They also made bone awls, pins, needles, dartheads, spears, hollow bone containers, and ornaments. They practiced careful burials and began an art in miniature sculpture and colored these figures.

Garrod (1938) has shown that the first invasion of Europe in Middle Aurignacian started in the East, perhaps from the Iranian plateau. She indicates that from Anatolia and Palestine the middle Aurignacian localities extend across the Black Sea and thence northwestwards into Central Europe and west into France and Spain. This route was followed by many invaders of Europe during early Neolithic times and later. Europe is no continent, no new land mass unto itself. Europe is a peninsula of Asia and a small one territorially.

It is usually held that there were no missile weapons until upper Paleolithic times, although the throwing-spear is found in the lower Paleolithic. Previously, when the last great Ice Age was approaching

Europe, specialized weapons made their appearance, usually pointed flakes for attachment to wooden handles. These were the spears made by the Neanderthalian "cave" men who killed and ate mammoths and rhinoceroses. Missile weapons revolutionized hunting and the Aurignacians, who also lived in caves from Palestine to western Europe, made bone and ivory dart-heads for their hunting of horse, bison, mammoth, and rhinoceros. In South Russia of this time tanged flint blades, thin and narrow, were made by the Gravettians. These folk, exposed to the icy blasts of "polar" storms, dug shelters and roofed them with hides and sod. At Kostenki on the Don River one of their "houses," 115 feet long and 18 feet wide, was uncovered by Russian archaeologists. There were eight fireplaces in a row down the center of this communal shelter for possibly eight families. They burned mammoth marrow bones on their treeless tundra and their fire hearths had conical draft flues. They appear to have clothed themselves like Eskimos, with skin trousers and headgear. Their camp-sites and corrals were usually along tributary river valleys, for shelter from the icy Arctic blasts. Storage pits for winter flesh like those in use in the Siberian tundra today for meat and fish were found nearby the dwellings.

The blades of the Gravettians could pierce the toughest rhinoceros and mammoth hides. These folk followed the huge herds of mammals, just like our Plains Indians followed buffalo. Vast heaps of bones were left by them on their camp-sites, which were even then being covered by wind-blown loess, the powder ground by glaciers and glacial streams, under tundra-steppe conditions. Finally, the Gravettians turned up in France (Gravette in Perigord) with their tanged points for shaft and spear-thrower still used by the Eskimos and Australian aborigines, as was the *atlatl* of the pre-Columbian-post-Erikssonian Mexican. The Aurignacians also were fishers for large fishes, like salmon, in the brimful glacial-fed rivers of Europe.

Altogether, the Aurignacians were variegated enough to serve as ancestors to the modern world, which some writers believe they were in fact. Certainly, the only good evidence of the origin of modern ethnic units suggests that Cromagnard influence can be seen in Europeans, the Eskimo, Amerind, Negro, Mongol, and Melanesian.

Solutreans

Following the Gravettians of the Aurignacian Epoch comes a remarkable brachycephalic and dolichocephalic folk, called the Solutreans from their station of discovery at Solutré, France. They may have come out of Asia, as did the Gravettian, and numerous other groups to follow

in post-glacial times, but finds of their remarkable tools made by pressure flaking, not pounding, have been uncovered in Kenya Colony, North Africa, Egypt, Hungary, and western Europe.

At Solutré, at the foot of a sheer cliff which overlooks a plain, an enormous mass of bones was discovered—mostly bones of horses. The hippophagous Solutreans had made two hedges of stakes and presumably by shouting and waving torches, stampeded the unfortunate animals over the precipice. Horseflesh has been eaten by many folk in historical time and a large "Chateaubriand" steak as it was served in Europe was not without merit, when French chefs prepared it. The food is replete with vitamins and minerals, but lower in thiamin content than pork. The high glycogen, or sugar content, is noticeable. During the Mesopotamian campaign in World War I, troops were on occasion fed horsemeat from badly depleted animals having no fat. Gastro-intestinal upsets of a mild mature followed, but this condition was corrected immediately when fat was added to the diet (pp. 103-104).

The vast camp of the Solutreans on a plain near Lyons was probably a summer station. The remains of 100,000 horses and 35,000 razor-keen laurel-leaf blades of stone, and flint tools, were also found there. These hunters are supposed to have remained in Europe only a relatively short time—some authorities conjecture 10,000 years—and disappeared mysteriously about 20,000 years ago.

About this time the Aterians in North Africa began making crude arrowheads, a tremendous step forward, which made possible a more varied and greater meat supply, together with articles of clothing. This invention spread slowly to the Capsians in North Africa, and to Spain, where the Gravettians still flourished. North of the Alps and Pyrenees, the arrow was not used until the Mesolithic Age.

Seasonal changes, with changes in food supply, profoundly affected nutrition of food-gathering folk. This fact has been amply attested to by many ethnologists, but the nutritional factors need further study, although the summer and winter foods of the Eskimo are fairly well known and appear adequate nutritionally, if not in volume.

Knowledge of early man in the Old World is changing rapidly and when the disagreements of authorities in anthropology and archaeology seem ever to be widening, we risk much in oversimplifying our introduction to the story of Paleolithic and Mesolithic men. Obviously, the data in this field are fragmentary, as in all other sciences. Certainly, the effects of *time lag* in cultures tax the ingenuity of prehistorians.

The Solutrean culture in eastern Europe—the Moravian stations—like those of Predmost and Vistonice, are labeled Predmostian. At

Vistonice near Brunn in Moravia, according to Dr. Karl Absolon (1929), director of excavations in Moravia, there was found in 1926 a huge heap of mammoth bones (over 2,000), mostly of young animals probably killed by being stampeded over a cliff. The young were easier to frighten and more tender to eat. The Paleolithic hunters probably utilized only the most edible parts including tender muscles, liver and brain, and also used ivory tusks, but abandoned the rest of the carcasses just like Plains Indians did when buffaloes were plentiful.

The fire drives and beating drives to corral food animals and also to drive them into pitfalls and traps, or over cliffs, are methods which have been employed by both Pleistocene and modern men. Yesterday some Eskimo groups drove caribou from the hills into a narrow valley towards a line of concealed bowmen. Parallel lines of small stones or piled sod were erected to guide the beasts, thus reducing the number of hunters needed for beating. Some paintings from caverns of late Paleolithic period represent enclosures and traps.

Charcoal from the Dordogne "art" cave at Lascaux, France is dated by radiocarbon as 15,000 years old (15,516 ± 900). Arnold and Libby (1951). V. Gordon Childe (1950), comparing selected radiocarbon dates with historical ages by archaeological methods, observes that discrepancies of the radiocarbon dates cause the archaeologist to wish for more checking and greater refinement of the methods. The student may read a discussion on the reliability of radiocarbon dating of archaeological materials by H. H. Bartlett (1951), who points out carbon contamination from extraneous sources. A report on radiocarbon dating by the American Anthropological Committee, F. Johnson (1951), and Dr. W. F. Libby's "Radiocarbon Dating" (1952) may be consulted for precise information. Perhaps the carbon dating from the Lascaux art cave cannot be correlated with the magnificent murals, Movius (1951).

The Lascaux Discovery of 1940

Aside from the many well-explored caves of southwestern France and in Spain, a new cave, possibly sealed for 20,000 years, was discovered near Lascaux on the Vesere River, Bordeaux. The find was made by four French schoolboys and their dog, Robot, one September day in 1940. While hunting rabbits, Robot disappeared. The boys heard barking from beneath a small hole covered with bushes. They enlarged the hole with their pocket-knives and the oldest boy scrambled down to rescue Robot. Lighting matches, he saw a long corridor ahead. Entering the long-forgotten corridor, the boys edged along a ridge of fallen earth until they reached a cave 50 feet below ground, shaped like an upturned

boat, 30 feet wide and 90 feet long. By their flickering lights, they made out 500 paintings in red and black etched on the whitish stone walls—an immense cavalcade of fantastic animals.

Not until after the war were the paintings photographed and examined by experts. The lifelike paintings, drawn on calcerous rock with natural indelible colors of ocher and oxide of manganese, were preserved by the dryness of the cave. Some appeared to have been made with finger smears or by puffs of paint blown through hollow tubes of bone.

Some of the oldest paintings, dating back 30,000 years, are marred by other works superimposed 15,000 years or so later. Arrows pierce the hides of many of the animals and all the female beasts appear pregnant. A huge rhinoceros seems to be wearing a woolly arctic coat. A reddish stallion, his body shaded to indicate a third dimension, has been chasing his mate for at least 15,000 years. Other wild horses, some bearing a likeness to the Shetland pony, gallop across the walls in full stampede. One unlucky horse is pictured toppling over a precipice, its forelegs thrashing in the air. A hump-backed bison, its entrails dragging in the dust and seven arrows sticking in its flanks, charges a gored hunter. The hunter, with a head like a bird and a body like a stick, falls backward with his arms folded. Two other jet-black bison hurry away in fright. Nearby is a bird perched on a curious totem pole.

Other paintings portray hyena-like beasts, Mongol-like horses, and deer with huge antlers and thin legs. A giant black bull 18 feet long is the largest single painting, partly obscured by galloping horses drawn thousands of years later.

There are numerous symbols and dots, perhaps marking the beginning of writing. Close to many of the paintings are curious eye-like signs, probably meant to represent the sharp eye of the hunter. This cave is the finest and best preserved gallery of prehistoric art ever found. Professor V. Gordon Childe (1948) calls attention to the fact that Aurignacian and Magdalenian art was practical in aim, and designed to insure a supply of those animals upon which the group depended for food. Magic rites have always been important in the food quest.

Cave animals may have been smothered by smokes. Grassland animals were driven by fires, but Dr. L. C. Eiseley (1946) in his observations on the fire drive and extinction of the terminal Pleistocene fauna, rejects Dr. Carl O. Sauer's theory that the great extinction resulted from prairie fires and game drives. (A stampede of 53 Palomino horses escaping from a blizzard in January, 1950, caused their death as they plunged over the Badlands natural wall at the Pinnacles, south of Wall, South Dakota.) Paleolithic men used resinous wooden torches, as well

as animal tallow lights and beeswax for lighting and drives. Beeswax with its pure, brilliant light, was suited for cavern illumination.

In the Predmost loess, Dr. Absolon (1929) uncovered many fossil specimens of these men. He also discovered mammoth thighbones, arranged in a semicircle with their ends charred from use as "fire-logs." When the huge bones were heated the marrow-fat exuded, serving as a continuous torch to keep the fires burning.

The Predmost skulls resemble the Skhul crania of Mount Carmel very closely, both metrically and morphologically, indicating a Neanderthaloid descent or admixture which could have taken place when Cro-Magnon hunters met local Neanderthaloid survivors.

Tribal confederations took place in Europe before the end of the Pleistocene, as must be assumed the case with these mammoth hunters of Moravia. The camp near Predmost covers over 1,000 acres. The horse camp at Solutré, in Central France, extends over two acres. The Predmost culture was very rich in worked bone implements. There is evidence of cannibalism among these groups.

Magdalenian

The Magdalenians were, as a group, slenderer in build and less powerful than the earlier Cro-Magnons. These favorably-featured folk were both longheaded and brachycephalic. They prospered in their southern France-northern Spanish focus where their great naturalistic art is confined. In England, Italy, and the Danube region, their culture resembles the earlier Gravettian, while around present-day Hamburg, Germany sites contemporary reindeer-hunters appear to be Magdalenians (pp. 35-36). The contemporaneous Afalon folk, or Capsian, of North Africa seem to be closely related in physical types to the Cro-Magnons. If the cavern art showing the bow in eastern Spain is contemporary with Magdalenian, then the bow and arrow may be late Paleolithic, although it is usually taught that the bow is Mesolithic. At any rate, the Magdalenians made sewing tools, harpoons, and spear-throwers and their industry presages the discipline of the Neolithic. Their food animals were reindeer and horses and their foods were almost entirely of animal origin, including much fish. During the later Magdalenian period plants begin to appear along with animals on the walls of the art caves, indicating perhaps the importance of plants in the food quest and the dawn of the interest in agriculture.

The huge mammoths and rhinoceroses had disappeared at the beginning of the Magdalenian period, so that their stone-flint craft declined because antlers and bone were preferred. Apparently clay pottery was not made although clay was used for modelling. It was a

tundra culture and extended across Europe into Siberia and the East. Their masticatory apparatus was of the Eskimo type and these hunters were short in stature. The Magdalenians of France developed fish-spears and harpoons of reindeer antlers. Fishing in well-stocked rivers would tend to curb a nomadic life. Caves and rock shelters were occupied during winter (November to February), according to the biological evidence, and in summer the hunters moved off to the grazing grounds of reindeer and the salmon fishing rivers nearer the sea. Seals were also caught. They trapped large numbers of arctic grouse and hares under snow cover in winter. Fresh water fish (pike, trout, chub) were taken near the caves. The reindeer may have also, as with modern Siberians, furnished the Magdalenians in winter with paunch ("half digested sour mash in reindeer stomachs"). Lechler (1945) shows this vegetable supplement to the diet to be a rich source of vitamins and iodine derived from the lichens on which the reindeer grazed.

The upper Paleolithic of North Africa is called Capsian by the French from the town Gafsa, Tunis. The Capsian was a blade and bone tool culture. Their food animals were largely elephants, large-horn buffalo, rhinoceroses, zebras, and also ostrich eggs. Billions of land snails mark the camp-sites of these folk. There were still small wild elephants in Tunis during Roman times. It is difficult to date extinction of many Pleistocene animals in both the Old and New Worlds.

The Magdalenian was the longest of the upper Paleolithic culture periods, lasting from the height of Wurm II cold until the retreat about 11,000 B. C.[1] As with the preceding Solutreans, they adapted themselves to cold conditions, but during the long Magdalenian period there must have been many migrations, shifting with the changing climate as the men followed the herds of reindeer, their chief source of food. The true Cro-Magnon of the earlier Aurignacian culture also survived into this long period. There was reduction of brow ridges and molars during the period under the same geographical conditions. Many of the basic characters for recognition of the white groups and subgroups were present at the end of this period and the beginning of the Mesolithic culture period (which extends roughly from postglacial time to 3000 B. C. and much later in many regions, depending upon the ever present time lags). Some pessimistic writers assert that a serious obstacle to progress may lie in the discovery that man's biological evolution ceased long before he became civilized, and that increasing knowledge creates superdifficulties but not supermen, so that the gulf ever widens.

[1] Dr. W. F. Libby (1951) finds radiocarbon dates for some late Magdalenian materials to be 15,487 ± 1200 years, 12,986 ± 560 years, and 11,109 ± 480 years.

Cromagnard Diets

While the upper Paleolithic folk subsisted on foods of animal origin, they apparently ate some fruits, nuts, roots of vegetables, leafy vegetables, and berries seasonally. It has been asserted that some of the Cromagnards may not have eaten much muscle meat, because there are no bones of food animals in their caves. Certainly, the bones of a mammoth or woolly rhinoceros were too big to carry away with ease. We can compare these hunters with our Plains Indians after they acquired the horse from the Spanish Colonies and gave up peaceful farming to live the life of daring buffalo hunters. They grew into big warlike men, eating only their concept of choice tissues of the bison. Francis Parkman, the great historian who lived with the Ogillallah in 1846, observed them to eat certain tissues of the young cow bison: raw liver, marrow, tender muscles, paunch linings, ductless glands, hump, and tongue. Their vegetal foods were nuts, cherries, plums, gooseberries, currants, and some corn. Likewise, the Cromagnards probably ate only organs, fat, some tender muscles, bone marrow, and brains. Fresh meat killed, cut up, and eaten on the spot is a valuable antiscorbutic (vitamin C) as Roald Amundsen and Dr. Frederick Cook knew practically, and later Dr. V. E. Levine (1941) showed in his work on Arctic diets. So far as frozen foods are concerned, the mineral, carbohydrate, fat, and protein constituents are not notably affected by freezing and subsequent storage.

Scurvy is unknown among our "Stone Age" Eskimos. They get about 40 mg. of vitamin C, or ascorbic acid, per day, according to the studies of Hoygaard and Rasmussen (1939). When living on an exclusively lean meat diet, even when the meat is boiled, they obtain about 25 mg. per day. For instance, the tissues of fiord seals show in mg. of vitamin C per 100 gm.: meat two; adrenals 127; thymus 26; liver 18; kidney 13; and blood three. Eider duck livers show 17 and crayfish three. The Arctic plants: rosewart 17; dandelion leaves 15; and willow leaves 18. The tissues and blood of a freshly killed animal retain ascorbic acid without great loss for 24 hours under ordinary refrigeration, but for only three to six hours when not refrigerated. Arctic explorers like V. Stefansson noted that pristine Eskimos looked upon anything from the vegetable kingdom as a substitute for food, to be eaten without gustatory pleasure.

Bison and water buffalo meat show the same nutritional values as meat from domesticated beef, Ikenoue (1943). According to our laboratory data, generally all muscle meat of mammals contains the same nutrients. Thiamin content varies with varying feeds, especially in the pig. Daily ingestion of liberal quantities of meat (liver, kidney, muscle) effects profound physiological benefits due to the content of B_{12} vitamin.

Plant foods are practically devoid of B_{12}. B_{12} increases the ability of man and mammal to utilize protein, increases resistance to cold, and markedly increases the growth rate and size of experimental animals. Meat supplies high quality protein (essential amino acids, animal protein factor or B_{12}, iron, and essential vitamins of the B complex). B_{12} is effective only when the diet is good.

The comparative leisure afforded the Cromagnards by their abundant food supply was utilized in sudden improvement of flint and stone work, and above all the cavern art, exhibiting new powers of artistic skill and observation of animals the hunter desired. Here is revealed for the first time the genius and aesthetic feeling of *Homo sapiens.* Higher cultures to follow often flourished where the need for unremitting effort to procure food was absent, and where there was leisure unburdened with anxiety, Sayce (1933).

In writing on Food and Health, Dr. C. G. King, Scientific Director of the Nutrition Foundation, stated:

"There is much evidence from human experience to substantiate the statement that vigorous living is both higher, and covers a longer span of years, when the food intake is consistently of high quality, but it is fragmentary compared with the records available from research with experimental animals. No more convincing demonstration of its truth has been given than is found in the reports from Professor H. C. Sherman's studies at Columbia University. One reasonably good diet, as gauged by conventional standards of growth and reproduction, has been under continuous study through 70 generations of albino rats. Their overall performance has been satisfactory by analogy to human experience; they have never shown specific signs of nutritional deficiency, as commonly found in our human population; no hint of vitamin, protein, fat, or mineral deficiency was evident, and certainly there was no lack of calories. But when the diet was made more generous in content of any one of the four nutrients, calcium, animal protein, vitamin A, or vitamin B_2, there was distinct gain in health as measured by earlier maturity, longer life-span, and greater success in rearing their offspring. Comparable gains were obtained by increasing the proportion of milk solids or meat-plus-calcium in the diet.

"The importance of balance was again illustrated in the above meat-supplement tests, when it was found that an increased growth rate resulting from increased intake of meat was detrimental unless accompanied by an increased provision of calcium; then the combined effect was beneficial. The margin between superficially 'adequate' and optimum intakes of each nutrient varied considerably from one nutrient to another, but the optimum level in each case was well above the adequate level. In

the case of vitamin A, which was studied in greatest detail, a 'plateau' of no further gain was reached when the intake was about four times higher than the 'adequate' level."

Those who would like to have a glimpse and a taste of the life of our ancestors during the Ice Age might find what they want in Norway, if they hurry. A reindeer killed with a stone-pointed lance some 4,000 years ago was recently discovered (1947), deep on the Lesja icefield, near Stralsund. Its meat is said to be edible and is to be preserved for the benefit of world scientists who might desire to sample it as food. A similar "banquet" for world scientists was held in Russia in 1912 with mammoth meat for fare. This mammoth is even older than the reindeer —10,000 to 15,000 years old, and preserved in the perma-frost of the Siberian tundra—but was eaten without serious after-effects for the Paleontologic gourmets who took part in the scientific congress of what was then St. Petersburg, L. B. Jensen (1949).

The barbed bone harpoons used in the upper Paleolithic and by the Amerinds of a few years ago, are still used by Eskimos for seal, by the Andamanese for sea turtles, and by the hairy Ainus and Kurile Islanders. Polybius (135-50 B. C.) described the selfsame harpoons in use in the Mediterranean basin for spearing swordfish.

Skin Clothing and Leather

Cave and ground dwellers, called Troglodytes by the literate ancients, dressed skins and hides according to their needs and crafts. In glacial Europe and western Asia and Siberia warm clothing was obviously needed to an extent not experienced in the Fertile Crescent. All dwellers in the summer tundra are plagued with mosquitoes and biting insects to an extent equal to that of dwellers in the moist tropics. Eskimos dislike the summer season for this reason and for formation of impassable morasses, as well.

Warmth and protection against insect pests, thorns, and brambles—not modesty—prompted man to wear skins and hides as clothing. Montaigne in his Essays quotes the retort of a practically naked ragamuffin of Paris to those who took exception to his attire: "You have your face bare; well, I am all face!"

Man was able to extend his nonspecialized functions, i.e., dress in skins and furs to extend the use of skin and fire; invent weapons to extend arms and claws, and devise shields; prepare cooked foods and devise or find new foods by experiment; eventually to domesticate beasts of burden and transport; and above all to lengthen the lion's skin with a fox's tail. While the woolly mammoth and rhinoceros became highly specialized, man adapted himself to most environments, although the

mortality rates must have been appalling. Bodily or somatic adaptation without intelligence is fatal to a species when conditions change drastically. Man inherited by tradition, speech, and finally writing.

Tanning of skins was invented at a late date, but methods of skinning and scraping the flesh side of a hide or skin, using elaborate methods with numerous stone tools, was an inheritance of countless ages. In the Mesolithic, and before, skins were fleshed with a grainer stone tool, and fat of brain and other fats were rubbed into the skin for pliancy. Dehairing dried rawhide, or bating and puering so that bacterial action on the "enamel side" permitted hair-slip, was practiced in the Neolithic. Sometimes the hides were smoked for preservation, Mason (1891).

Leather was worked in Ancient Egypt and the preserved specimens of 3000 B. C. bear testimony to the high state of development of the art of tanning. When man first began to kill animals for food, the art of drying skins may have appeared. While dried skins are hard and stiff but become softer after being worked, it was probably noticed that softening was more pronounced if fat remained on the skin or if oil was added.

If hair-slip was due to putrefaction or poor drying, it was observed that hairless leather possessed great advantage over hair skins for certain purposes.

The tanning and coloring action of leaves, barks, and woods was probably also an accidental discovery. Man made vegetable-tan liquors from bark of hemlock, gambier, wattle, oak, chestnut, larch, and sumac. In fact, many tannery operations of today are of prehistoric origin! Even dry raw skins if wetted become putrescible. In pre-history it was learned that extracts of bark, leaves, wood, and brown pools of water in forests, when coming in contact with skins or hides "tanned." Skin protein and tannins formed a compound—"leather."

Samples of Bronze Age leather from Denmark show evidence of having been treated with clay salts to soften for use in sandals.

Skin boats of the umiak and coracle types, well oiled, were in use in Europe for millennia and are still in use from Greenland to Siberia. The Magdalenians sewed leather or skin garments, and the Mesolithic and Neolithic folk wore leather, furs and seal skin clothes, jerkins and sometimes caps. Leather containers for liquids were in use early in the metal ages, and leather bellows were needed by smiths. Harness for domesticated animals furnishing motive power for cultivation and transport was often made of leather. During the Bronze Age leather was used for shields and sword, dagger, and hunting knife sheaths. Bags for water, and leather tool bags have been found dating from Hallstatt and La Tène times.

CHAPTER IV

The Mesolithic Period in Europe

Climatic Changes

The Mesolithic Period is an extension of Paleolithic culture, beginning with the Holocene or Geological Recent of 8000 B. C., when the climate had changed from glacial to modern. Great changes in flora and fauna resulted in drastic changes in food supply. Table 5 shows at a glance the climatic sequences in northern Europe, where the Paleolithic hunters and gatherers had adapted themselves well to the cold maximum of the last glacial. Archaeological and historical periods of northwestern Europe, compared roughly with the Egyptian and Near East sequences, are shown (Table 6) without further comment.

The final European glaciation centered in the Scandinavian Peninsula, but the western coasts of Norway were open, like the west coast of Greenland today. The greatest effect of the climatic change in Europe was a *gradual forestation* of the tundra upon which man's plentiful food supply of animals had roamed. For instance, the late glacial park-tundra shows herbivorous mammals, bison, horse, reindeer, and elk. The giant Irish deer became extinct with extension of forests, which reduced its grazing and sheltered its carnivorous enemies. Typical forest

TABLE 5

The Baltic in the Mesolithic Period

Years B. C.	Climate	Baltic phases	Archaeology
2000	Subboreal warm, dry	Litorina salt	Neolithic
2500	Atlantic warm moist		Ertebolle
5600	Boreal warm, dry	Ancylus fresh	Maglemose
6800	Pre-Boreal forests	Yoldia salt	Ahrensburg
		Ice dammed	Lyngby Antler axe
13000	Last glacial	Ice	Upper Paleolithic

TABLE 6
Archaeological and Historical Periods

Years	Climatic phases	Northwestern Europe	Egypt	Hither-Asia
1000		Dark Ages	Islam	Islam
500 A. D.			Roman	Parthian
0	Sub-Atlantic	Roman	Ptolemaic Persian	Persian Assyrian
1000 B. C.	Subboreal	Iron		Kassite Babylon
2000		Bronze	New Kingdom	Ur III Akkadian
2500		Neolithic	Old Kingdom	Dynastic Jemdet
3000				
4000	Atlantic		Predynastic	Uruk Al'Ubaid
5000		Mesolithic	Merimdian Fayum	Neolithic
6000	Boreal			Natufian
8000				

animals were red deer, elk, roe deer, pig, wild cattle, furry fox, martin, badger, beaver, and the large cats.

Foods and Cultures

In Europe the period may have extended from 12,000 B. C. to 3000 B.C. or later. The people were still food gatherers. The population was as sparse as prior to the time man domesticated the dog for hunting, but apparently the dog was not eaten during this period, as was the case after 3000 B. C. in Mesopotamia and in Greece in classic times. Technology improved in weapons, axes, and basketry. In contrast to the end of Paleolithic cultures, the Mesolithic societies leave the archaeologist with an impression of extreme poverty:

The Tardenoisian culture came in from grasslands of northwestern Africa, and perhaps the eastern Mediterranean, the movements caused by climatic shifts following the glacial retreat which resulted in desiccation of the southern temperate belts of North Africa and Hither-Asia. The climate of Europe in early post-glacial times became warmer than it is at present.

The surviving reindeer hunters, with the advent of warmer climate and the growth of forests, had to learn new technologies, usually for fishing and mussel gathering. In the north of Ireland, Scotland, and Norway, the old flint traditions survived until Imperial Roman times. North Africans and the Asselar man of South Sahara (some 300 miles north of Timbuktu) lived then on a well-watered plateau grassland with brimful rivers, lakes, and plentiful game and large fish.

The small Natufians of Palestine of that period are said to resemble Europeans generally of upper Paleolithic times, and also to resemble Mediterranean types with negroid affinities living today.

While the Mesolithic people or perhaps early Neolithic folk of the Tagus river in Spain were marine shellfish eaters of Mediterranean types generally, they had the dog, and ate flesh of wild cattle, deer, sheep, horse, pig, wolf, cat, badger, civet, and hare. These people seem identical with Natufians. In France they ate shellfish, crustaceans, and fish, but seem to have done little hunting (4000 B. C.). They appear to have mixed with resident food-gathering Magdalenians.

In the Ofnet cave in Bavaria 33 skulls were found in a circle like eggs in a nest. Nineteen were children, 10 women, and four were men. These poor folk had been murdered in Mesolithic time, all their skulls showing fractures from impact of a round poled celt, or axe. The victims were Tardenoisian in culture. Skulls, which were covered with red ocher, showed a very mixed race. These folk practiced tooth knocking (incisors) like Natufians. It is conceivable that tooth knocking could lead to faulty mastication and impaired digestion, although this point is controversial. Certainly, the modern Arunta of Central Australia practice knocking of their incisors and they are well-nourished withal, when they have a normal food supply.

In Boreal times the bed of the North Sea rose and England and Scotland were joined to Denmark by dry land. Sometime between 6800 and 5600 B. C. migrants resembling the Ofnet folk in variety came north. With melting of the ice the oceans of the world rose. The land connections with Britain were again covered by the sea and the Baltic became salt. In Denmark the Ertebolle people were gatherers and fishers, and the huge kitchen-middens or shell-heaps containing food

animal bones as well as pottery, testify to a fairly dense population, as density is understood before food-producing times.

When the Neolithic farmers and stock raisers reached Denmark and southern Sweden around 2500 B. C. they found these sedentary folk, as well as preceding hunting peoples, but coastal fisherfolk can resist invasion better than hunters, so far as survival goes.

All of the invaders of the Mesolithic age in Europe came from North Africa. Eastward on the drying western plateaux of Asia man was learning to cultivate wild grasses like wheat and barley, and to domesticate the barnyard animals we have today.

In Russia and Poland, Belgium and Germany, the cultural assemblages found are small arrowheads derived from the large darts used by the old mammoth hunters. The Azilian assemblages show that cave dwellings were still used. They lived in small isolated communities but possessed boats of a sort.

The folk of Tardenoisian culture lived in flimsy huts on sandy soils and in open caves along open European shores. They ate shellfish. Many of them were brachycephals and from their practice of midden burials were probably immigrants of North African Capsian origin, driven north by the drying Sahara.

The Asturian culture succeeded the Azilian on the Iberian peninsula. These people were also shellfish eaters. The high incidence of acute shellfish allergies in present populations is sometimes thought to originate from the long eras in which shellfish were chief articles of food, but obviously this assumption is highly speculative. The evidence of low vigor in cultures subsisting mainly on shellfish can be seen in the Capsian of Spain, Tardenoisians of the French Atlantic, the Obanians of Scotland, and the Ertebolle. The possibility of grave thiamin deficiencies from destruction of thiamin by thiaminase of shellfish should not be overlooked. The enzyme in these foods is destroyed by cooking.

In Boreal times the forest folk spread through the pine forests from southern England to Finland, where they joined with Tardenoisians. In Holstein, a short distance east of Hamburg, the important site of Meiendorf, a reindeer hunters' camp, was discovered in 1933, underneath several yards of peat. The culture is Magdalenian, but the time is about 13,000 B. C. and is the latest known phase of true Paleolithic, Rust (1937, 1943). About 400 yards north was found another site, the Stellmoor reindeer hunters' camp, with Lyngby axes[1] and flint imple-

[1] Lyngby axes are unique axes of reindeer antlers in which the brow tine was trimmed to form a socket for a flint blade.

ments but Mesolithic in time, the earliest Mesolithic site that has been dated by pollen analyses.

The Ahrensburg or Stellmoor lake-bog camps near present Hamburg show the foods to have been fish (pike), birds, nuts, and reindeer—a Lyngby culture, as in Denmark. The first game of the season were weighted with stones and thrown into the lake as spirit offerings, and a reindeer's skull mounted on a post was planted like a totem pole. These sites were summer settlements. The glacial tunnel valleys of Schleswig-Holstein provided grasses and sedges, small willows and birch, the favorite reindeer *(Rangifer arcticus)* food in summer.

Hide-covered boats were used as well as dog sledges in winter—the dogs ancestral to sledge-dog breeds. Amber, collected in Denmark, was highly prized because of its magic electric properties, and later in Neolithic times was an article of trade in Mediterranean lands and the Near East for millenniums. Nothing we have today can compare with the value assigned to a life-giving amber amulet.

After marine transgression broke up these cultures huge oyster beds, together with sealing and coastal fishing with boats, resulted in permanent settlements known as the Ertebolle culture. Fish were caught with hook and line. Herring do not appear in the prehistoric sites in Europe. Pottery was common, as well as ground stone axes. Their pottery is thought to be a local invention. It has been shown recently by T. Matthiassen that the Ertebolle midden people of Denmark made pottery before the spread of food production into temperate Europe. This pottery was built in coils which indicates coiled basketry models of the Mesolithic. The leather vessel appears to be a prototype of western Neolithic pottery, and certainly hand-cut wooden bowls were a pattern source of ceramics. Containers made of bark of birch, lime, and pine may have competed with pottery in the northeast forests. Stave-built buckets were developed in the late Bronze Age of Europe. They did not have animals which could be domesticated as food animals, or cereals to develop.

TABLE 7

Sequence of Baltic Cultures and Climate

Date, B. C.	Culture	Climate
8300	Lyngby	Pre-Boreal
	Tardenoisian-France-Azilian	Pre-Boreal
6800	Maglemose	Boreal
5000	Azilian	Atlantic
	Ertebolle	Atlantic
	Neolithic I	Atlantic

When the Baltic was a fresh-water lake, a Maglemosian culture existed on the north European plain and in Denmark and Scania (then joined by a land-bridge) so called from the great bog (Mikil-moss) of Mullerup in Denmark. These folk lived on pine-log rafts moored to the shore. They were pike and eel fishermen, but ate elk, stag, pig or boar, ducks, geese, and other waterfowl. They also gathered seeds of the yellow water lily for food. Kitchen refuses thrown into the water are now revealed as layers resting between layers of peat which were exposed when the lake shores receded. These descendants of Cro-Magnons used horn, bone tools, chisels, awls, polishers, needles, fishhooks, harpoons, and small flints. They are now known to have used bows and arrows. The oldest fish hooks and nets known anywhere were used by the Maglemosians. From their era to recent times the fresh water pike was highly esteemed. The Kitchen-midden culture then followed, which was shorebound, so called from enormous heaps of oyster shells and cockles. It is now called Ertebolle culture, after the site in Denmark where were found bone, antler or stag horn tools, flint hatchets, picks, and crude pottery suggestive of a Neolithic marginal culture. The people obviously were still food gatherers.

The Mesolithic was decadent in comparison to the old hunting cultures. New needs arose which were eventually met by Mediterranean folk who came up into Europe, and men from the Caucasus, whose cultures led to the Neolithic Revolution in Europe. We shall see an age of tremendous consequences arising from discovery of (1) laws of agriculture, (2) animal husbandry, (3) pottery, (4) weaving, and (5) grinding and polishing (and superior tools which culminated in Egyptian building and art). We may note that where two or more of these five advances are found, the term Neolithic was formerly given to the culture.

The effects of time lag of cultures so noticeable in the pre-history of Europe, where hundreds and sometimes thousands of years elapsed for diffusion of important new facets of cultures, are so very much longer in food-gathering cultures. This is explained by Macalister (1949) from the mode of life of food gatherers who could have little room for new ideas, in environments in which they had survived through countless generations. Their isolation, often arising from geographic features, and their all-consuming drive for food kept them from other communities. However, the often-invoked isolationism of primal groups may not have held some groups of hunters in one area. They followed their game, and seasonal movements must have brought them in contact and into conflict with other groups of the same general cultural levels. The succession of cultures with their gradual advancements, and in some instances retro-

gression for a time, eventually culminated in food-producing times in the favorable regions of Hither-Asia.

The ancestors of the dark whites, according to Dr. C. S. Coon (1939), developed during the Pluvial periods of the Pleistocene in the then well-watered, now arid, zones reaching from the Sahara to northern India. Following the retreat of the last ice sheet these zones became arid, forcing the men who had developed agriculture and stock raising to follow the post-glacial zones of climate into Europe, where they encountered the Paleolithic survivors—hunters, fishers, and food gatherers—who in turn were retreating slowly to the North. These movements were not completed for thousands of years.

This Mediterranean stock was essentially white; the "Europeans" whom they encountered and with whom they mixed were often blond or rufous. From these numerous and complex tribal mixtures have arisen the Nordic, Alpine, Dinaric, Borreby-Brunn, Danubian, Atlantic, Noric, and a dozen more ethnic entities besides. There seems to be some controversy over the number of living ethnic groups in Europe, but the tendency is to increase rather than decrease the three old primary stocks of Professor Ripley (p. 174).

The Paleolithic survivors—much mixed, of course—are by no means inferior folk, and for the past two centuries have been in the vanguard of progress through their own efforts. No one really discredits the wonderful beginnings of food production and the effect of the new economies. One only calls attention to the favored climate and the zones resulting thereby for nurturing the indigenous cereal grasses and beasts ready for domestication, few of which were native to Europe. Emmer and barley will not grow on a glacier, nunatak, or on the refrigerated soils of the tundra. The mystery is: Why was not food production learned millenniums earlier in the many favored southern zones?

Three basic innovations characterize the Mesolithic: invention of the bow, domestication of the dog, which joyfully aided in hunting and guarding (or perhaps the intelligent, faithful dog attached itself to man), and the rude beginnings of pottery for boiling food. Warming of the northern waters nurtured an abundance of shellfish and fish, which resulted in shore dwellers, i.e., beachcombers who ate these seafoods as staples. The total populations no longer were red meat and marrow eaters as they had been in earlier times. With new foods listed here (waterfowl, eggs, seafoods and river fish, hares, slugs, snails, snakes, and roots, berries, nuts, and plants) less available in comparison to the large mammals, man generally had less leisure and certainly a less exciting life. To be sure, historical animals like deer, wild cattle, and

boar abounded and were hunted, but generally life became more tranquil so far as food gathering went. Some ethnologists, however, believe that man's inhumanity to man went on apace. Childe (1951) suggests that warfare in prehistoric Europe seems to have been an everlasting proclivity only after livestock breeding became important in rural economies.

With the coming of the new climate and environment of the Mesolithic, some of the groups dependent upon the large tundra mammals disappeared from western Europe. The new forests spread, with a new fauna of wild pig, red deer, and aurochs. New cultures arose, with adaptations of tools to meet the new food-gathering patterns; smaller flints with wood to haft them are found, and the heavier wood-cutting axes to cope with the forest trees. A comparatively general decline set in, but the old human stocks did survive. The Maglemosian of Denmark, the Tardenoisian of possible North African origin, and the Azilian beachcomber culture held sway over northern and western Europe and became established in the British Isles, where the descendants of late Paleolithic survivors, the Creswellians, were gathering their food. The Tardenoisians, as we noted, have been credited with domestication of the dog.

The diets of all of these folk were good enough where ample supplies were to be had. By fishing and fowling, the men obtained protein, which was supplemented to a greater extent than formerly by vegetable foods, particularly by hazelnuts. Shellfish became an increasingly important element of the diet of Mesolithic times. The foods were tolerably plentiful, at least in summer. During this later period, Britain was insular and had been so since 6000 B.C., although the Maglemosians entered England when the North Sea was marsh and fen. By the end of Mesolithic times the climate became very wet and misty, with dank oak woods and alder replacing pine forests.

In the Near East, however, men responded to a different change. Aridity following the shifting rain belts across the world at the end of the Ice Age forced men and animals to gather around oasis, lake, and river, and, according to present-day students, the invention of agriculture (mixed farming) came about quite suddenly—sometime between 8000 B.C. and 7000 B.C.—the greatest advance man has ever made, so far as we can see with our limited vision.

The increase in populations of the lands of the Neolithic Revolution led to land-hunger and demand for *lebensraum*. The exhaustion of fields sparked the urge for the peasant to seek new lands. Up the Danube basin, along the Mediterranean coastlands, and around the Pillars of Hercules into Spain and western Europe, these numerous but slow-moving communities came, with their cereals and livestock. Pigs, like

dogs, were attracted to man's communities by waste food. The herds of livestock never became large until root crops (turnip family used by the Romans, and in much later times in England and Europe) made better winter feeding possible. Many of the men still hunted; collected, fished, and fowled to increase the larder, as they have always done where game is to be had. When livestock breeding developed on a larger scale and the warrior class arose, hunting developed as a sport.

Stranded whales brought meat and fat for the coastwise folk of Europe during the Mesolithic until a century ago, and Olaus Magnus (1555) tells us that whales yielded meat for salting, blubber for lights and heat, bones for fuel, and hides for clothing. Seals and dolphins also furnished food and skins.

Part II

FOOD-PRODUCING TIMES

* * *

CHAPTER V

The Neolithic Age

Origins of Food Production in Hither-Asia

The essential material foundations of civilization are cereal and livestock farming and improving both plants and animals. Man did not or could not develop the arts and technology of civilized life until he passed from food-gathering cultures to the food producing stage.

In northeastern Iraq, at the pre-ceramic site of Jarmo in the foothills of southern Kurdistan, Arnold and Libby (1950) find the biological materials to be 6,707 $\pm$ 320 years old by radiocarbon dating, which is about 2,000 years later than the excavator's (Dr. R. J. Braidwood) date. The villages of the Iranian Plateau (Persia) were established under climatic conditions which appear in range to be much the same as the European weather of today. Other food-producing communities were forming from the Indus to the Nile delta and adjacent Merimde-Fayum-Badarian sites.

Dr. C. S. Coon and Dr. Louis Dupree in a recent expedition found in a cave on the shores of the Caspian Sea in northern Iran skeletons of *Homo sapiens* and a skeleton of a 12-year-old Neanderthal girl which they dated 10,000 to 12,000 years old. The three *Homo sapiens* skeletons were found in a layer of gravel 39 feet deep, deposited at the beginning of the last Ice Age (75,000 years ago). These older brain-cases were smaller than those of modern man. They were heavy-set people and stood five feet, seven inches, with low-placed eyes, long teeth, and perfect human chins. Agriculture was practiced at this site 6060 B.C., probably 1,300 years earlier than at the oldest site hitherto excavated. Arnold and

Libby's (1951) radiocarbon date (charred bone) for the Neolithic of Dr. Coon's Belt Cave is 8,085 ± 1,400 years.

Some occidental teachers of pre-history, until their military or political setback a few years ago, taught that the beginnings of civilization in the great Southern Crescent were but *le mirage Orientale*. Montelius and Sergi, who belatedly have received *double salve d'applaudissements*, said long ago that the Mediterranean people both fair and dark, are inseparably linked with the food-producing economy of Neolithic culture. Miss Caton-Thompson (1948) has shown the possibility of a central African origin for Neolithic civilization, but the numerous unopened *tells* of the Merv oasis. Transcaspian steppes, Iran, the Oxus and Iaxartes, Anatolia, and elsewhere in the Near East may furnish data to weigh the balance in favor of that general area as the first home of food production which catalyzed civilization. It is probable that the favorable zones where the gigantic changes in man's economy took place were in Hither-Asia, the Iranian and Indus highlands, where wild cereals grew and our barnyard animals then roamed wild. It is noteworthy that the now arid but then well-watered highlands, not the valleys, of the three rivers (Indus, Tigris-Euphrates, and Nile) were the favored areas for food production. However, other favored highlands where the new economy could have risen were Abyssinia and the Yemen. Decreasing rainfall dried out these little flare-like points of light of the ancient Paradise of dim tradition. The fertile areas of the Near East had been easy to farm, with their well-watered upland grasslands and fertile valleys. When desiccation set in, movements of cultivation to the large river valleys were natural. Seven thousand B. C. is often given as a date marking progressive desiccation in the Near East, but in the fifth to fourth millennia, B. C., the Iranian plateau had not yet become a salt desert. When meadows and shrub lands began to emerge from the swamps and mud flats of the old flood plains, man with his food-producing knowledge descended from the highlands, H. Frankfort (1951). With regular inundations or seasonal floods insuring soil fertility, the silted valleys afforded ideal conditions for rapidly growing cereals. Iraq offered the greatest abundance of food in return for the least skill, and the river valleys eventually became paradises for peoples who had learned simple forms of agriculture. The great river valleys and deltas, once jungle-swamps full of venomous reptiles and hippopotamuses, were through necessity slowly brought under cultivation. In the Persian Gulf, water teemed with fish, wild fowl, wild pig, and game. Date palms grew on every solid patch of soil, furnishing fruit of good nutritive qualities.

Dr. Thorkild Jacobsen (1946) shows how canalization and irrigation made the rivers work for man. These innovations called for group work of a disciplinary nature and man himself was domesticated, although he has ever chafed at the bit. A cycle in interplay of planned labor, which increased the food supply with increasing population of workers, resulted in increased complexity of organization, until we now have our industrial and social-political wheels creaking and rolling at great speed—no man knows whither. Montandon (1940) with unintentional levity, in his taxonomic table, groups contemporary man as *Homo sapiens sapiens!*

Jacobsen (1946) also shows that the spectacular rise in population in Mesopotamia around 3600 B.C. was undoubtedly due to devising large-scale irrigation by means of canals. The canals were not suddenly invented; they existed on a small scale earlier, as the evidence indicates. For the first time there was food in abundance, and a concomitant rise in population took place. There was better nutrition for more people and better soil nutrition to pass on from plant to animal and to man. There is no evidence of the use of fertilizer in Mesopotamia; rich river silt deposits during irrigation, as in Egypt, accomplished that. Dung was not necessary for the soil of the three valleys, but may have been used on the plateaux by the villagers in their permanent sites, since soil fertility was a problem in Neolithic Europe, where settlements shifted rapidly when plant foods or fertilizers were not added to soil.

Partially specialized and leisure classes of people arose with close contacts of many individuals, some of whom were nutritionally well off. This may have catalyzed a simple culture to a civilization, but it is not known precisely what else happened before civilization appeared. Most of the Amerinds were food producers, but only the Mayas and Incas were civilized. We may note too that fishers and hunters who developed methods for food preservation were better off than food producers who lacked such technologies. Literacy and invention are seen to catalyze still greater complexity, until, after a relatively short period, we observe cultural levels comparable with some of the higher levels of today.

Assemblages of Neolithic Villages

The technology of irrigation brought people closely together in cities, first small and soon relatively great, whereas the stay-at-homes remained on their arid highlands and oases as predatory feudists. The earliest village cultures like Hassuna of North Iraq, Siyalk I of northern Iran, Amouq A of the Upper Euphrates, Jarmo, Transcaspian Anau I, Jericho, Fayum, Ubaid, and Tepe Hissar, to name a few, were probably peopled with folk typical of the Mediterranean groups. Dr. W. M. Krogman

(1940), who studied the material from Tepe Hissar in the arid steppes which extend into Iran beyond the southeast shore of the Caspian Sea, found the skeletal remains to be those of true Caucasians of Mediterranean type, and a smaller number of skulls and bones most frequently associated with northern Europeans. Students of the early village settlements of Iran are impressed by the lack of war-gear of these cereal growers, even though many of these men were big-boned, robust individuals. The discovery of agriculture gave them earth-room to spare for hundreds of years, but climatic changes and the growth of towns ushered in man's everlasting proclivity—warfare. Cities like Susa formed, covering 300 acres on the then delta of the Tigris-Euphrates, when the central plateau was drying, in the Fifth Millennium. The delta lands were fertile and well watered. Susa had a battered existence for 4,000 years. Theology students tell us it was here that Mordecai hanged the hangman, Haman the Proud, on a gallows 50 cubits high. One group of the plateau people, anthropologically resembling modern English, became Sumerians, bringing with them a Ubaidian culture from the site of Al'Ubaid, now in the desert four miles west of Ur of the Chaldees. They were the first great dairy people. The pottery made by the earliest settlers of Sumer show that they came from Iran (Persia), H. Frankfort (1951).

Dr. John A. Wilson (1942) takes issue with the fetish of objectivity in reporting archaeological finds, and shows the rightful role of the excavator to be interpretation of the evidence. The digging archaeologist, like his confreres of the research laboratories, comes closer to the facts than the philosopher. "The most penetrating speculation becomes futile without experimental data," states the philosopher in self-condemnation. The tendency of different national groups of archaeologists was recognized by Carlyle, who long ago complained that students of man fail to tell us how our forefathers actually lived: "What all want to know is the condition of our fellowmen; and strange to say, it is the thing of all least understood or to be understood as matters go." The German school of archaeology shows greatest interest in architecture, the French in art objects, and generally there has been a haughty disdain of man's foremost need—food and drink—although one historian of the Near East about 20 years ago called attention to his new book in which he mentioned garments, another of man's material needs. Evidences of foods and nutrition in the sites may be of the greatest importance in estimating cultural values. However, the work at Anau by many specialists like Schellenberg on grains, Duerst on animal remains, and the work of the Oriental Institute of Chicago at Alishar Huyuk, shows how complicated and forbidding the primary sources have become.

The first marsh stratum of Ur is 60 feet deep and of another Sumerian city, Erech, 75 feet. These mounds, called *tells* in the Arabian world, dot the plains of Mesopotamia. Destructive agencies like rainstorms, quakes, war, and fire levelled a site of earthen and other buildings. The debris was levelled off and the site rebuilt, resulting in many strata before the places were completely abandoned. At Siyalk, tells were 90 feet high before the historical period. In Erech of the Bible archaeologists sank a shaft 75 feet into the mound. At every stage, or level, on the shaft's sides were pottery sherds, bricks, stone tools, and debris. At the bottom lay the virgin soil of a swamp of the former shores of the Persian gulf—the great delta having been built up over 100 miles in the course of written history. (Tectonic changes and climatic changes in the Near East are unsettled problems so far as they relate to the extent of the Persian gulf, pluvials and aridity of the Syrian desert.) The original Sumerians became mixed with aboriginal Semitic peasant folk, and eventually the Semitic languages and anthropological features became dominant. The Sumerian's smallest measure was a grain and his square measure was seed measure. His granaries were cylindrical or pyramidal, but the tax collector soon learned how to figure their capacities.

The Neolithic economy all over the Near East was much the same. Table 8 indicates briefly the earliest village culture materials found on a few excavated sites.

The Natufian assemblage of the Jericho mound shows grain-cutting and cereal-preparing tools, but it is not believed by some archaeologists that these Palestinians were farmers or gardeners. The Natufian is without pottery, but pottery may have been discovered before food production. They did not possess domestic animals, H. Frankfort (1951). From the Natufian to the basal layers of the mound, no clear-cut picture of transition to food production is seen, and the dozen or more earliest assemblages show, according to Dr. Robert Braidwood, that something not yet in hand must be back of this development. Dr. Robert J. Braidwood (1952) has in many important respects now closed the gaps in the transition from food gathering to food production in Iraq. His recent studies and excavations have shown the sequences: Zargi (preagricultural), Palegawra (Natufian, terminal food gathering, 6500 B.C. ± 1000), Karim Shahir (incipient agriculture and animal domestication, 5500 B.C. ± 500), Jarmo (earliest village site known, 4750 B.C.), Hassuna and Halaf (primary peasant efficiency, permanent villages, ceramics, weaving, earlier than 3000 B.C.), Ubaid (established peasant efficiency, market towns, temples, expansion into river valleys), thence to protoliterate incipient urbanization, early dynastic (3000 B.C.), and Akkadian times.

TABLE 8

Assemblages of Earliest Villages of The Neolithic

Site	Dating	Foods	Food implements and storage
Hassuna (N. Iraq)	5500 B.C. ± 500	Sheep, goat, ox, pig, wild game—no grains reported	Grain bins of bitumin-coated plaster—pottery husking-trays, sickle blade, hoe
Siyalk I N. Iran	5500 B.C. ± 500	Sheep, wild game—no grains reported	Querns and mortars, sickle hafts
Anau I S. Trans-Capsia	......	Ox, sheep, pig, dog, bread wheat, and 2-row barley	......
Ubaid S. Iraq	4000 B.C. ± 250	Mussels of fresh water, "meat bones"—no grain recovered	Hoes, hammer-axe, querns, mortars, pots
Amouq A Upper Euphrates	5500 B.C. ± 500	Pig, ox—no grain found	Pots, stone vessels, sickle blades, floor silos in Phase B
Jericho Neolithic	5500 B.C. ± 500	Cows, goats, sheep, pigs, dogs	Pots, saddle-querns, mortars
Tasian (Egypt)	5500 B.C. ± 500	Emmer, cat, fish, turtle	Querns, grinders
Fayum (Egypt) Upper K	6136 B.C. ± 320 from radiocarbon (wheat)	Clams, emmer, barley, flax, sheep, goats, ox, pig, fish	Sickle blades, pots, querns, grinders, silos, fire-holes
Troy I	3500 B.C. ± 200	Poppy seeds, legumes, goat, pig, deer, ox, fish, shellfish	Pots, querns, mortars
Thessaly I	3500 B.C. ± 200	Wheat, barley, figs, peas, almonds, acorns—no animal bones found	Ceramics

When the collectors (food gatherers) began to cultivate plants, and domesticate and tend to their flocks and cattle, they began to insure themselves against the uncertainties of food supply. The collector became a herder and gardener—a distant progenitor of our modern agriculture. Man's progress has largely been paced with his conquests of Nature's obstacles. He used fire very early to improve Nature's gifts. When he roasted his food (no pots or pans) he made it more palatable and sanitary. The nomad retained his fondness for hunting and fishing and still

found it necessary to collect certain foods (honey, berries, fruits, roots, nuts, and herbs). Many folk were at first both gatherers and cultivators. Some primal peoples in their development were herdsmen before they cultivated plants, and their animals furnished them flesh, milk, cheese, hides, leather, and wool. The ox furnished motive power. The movements of pastoral nomads in search of green pastures disseminated numerous kinds of people over the Old World.

The seasonal movements led to poor cultivation of crops and the yields must have been small after weeds and birds worked their havoc. There are reports stating that cereals, vegetables, etc. grown in this haphazard way have excellent flavors when compared to the carefully tended plants of commercial cultivation. It is also believed that much of the desirable flavor of foods has been lost during the past centuries. For instance, all connoisseurs of the tomato decry the tasteless, pulpy fruit purchased in city markets of today.

Some of the nomads reluctantly settled in villages to till their soil. This process was long drawn out (over 5,000 years of effort, according to the evidence from the Indus and elsewhere in the Near East). The loss of livestock through disease or "act of God" may have hastened settlement in many instances. All of the village groups were closely related.

Eduard Hahn (1896, 1905) distinguished sharply two forms of farming: hoe culture or gardening, and plow culture, the form of agriculture which obviously involved antecedent stock breeding. However, some primitive tribes advanced directly from hunting and gathering to farming, probably through diffusion and environmental circumstances. R. H. Lowrie observed four categories: hunting, farming with hoe, farming with plow and livestock, and stock breeding without farming (pastoral nomadism). For instance, pigs of some European settlements of the Neolithic could not be driven far, hence nomads did not utilize them. Dr. C. S. Coon (1951), from his findings in the cave-site three miles from the Caspian Sea in Northern Iran, indicates that goats were first raised for milk and meat, and that later cultivation of soil and pottery making were practiced. Then came sheep raising, and later the pig and ox are found. There are many perplexing and unsolved problems relating to the discovery of agriculture.

Civilization cannot exist without food production, but food production must be very efficient before civilization can begin. The transition from primitive to civilized life has happened more than once, but Mesopotamia and Egypt were the first cultures to rise above primitive existence, H. Frankfort (1951). Food-producing people need not be

"civilized," as we view the food-producing American Indians who raised corn, squash, pumpkins, potatoes, tomatoes, etc. There may not be one answer as to why men became civilized and the changes appear to defy recognition at the present time. Generally, the Neolithic man of the early village cultures showed patience and dexterity, although this trait can also be sensed in Mesolithic times. Even the Magdalenian arts of sewing, harpooning, and spear throwing presage the discipline of the Neolithic. The influence of one great man like Imhotep's supposed influence on early Egyptian civilization might have catalyzed progress.

It is to be understood that the transition to food production between seven and eight thousand years ago occurred in certain favored areas of the world only, and is still not completely achieved. Globally the goal has not been reached. Some of the human family are still in middle Pleistocene stages in their sustenance patterns. Efficient production and food preservation and storage determine to a large extent man's victory over Nature.

The chronology and sequence of growth of Neolithic villages, towns, and later, cities, will no doubt be established satisfactorily, but until this is accomplished, we can in our mind's eye see, about 7,200 years ago, small glowing embers of village hearths from North Africa to the Indus. Then, about 5,000 years ago, cities appear, like a color spectrum, in the favorable regions of the Fertile Crescent and India, while in China on the Yellow River could be seen a single ember. Paleolithic survivors and Neolithic raiders, the ancestors of the Bedawin, Hun, and Battle-Axe warriors, must have smelled disaster and strangeness on seeing these little towns glow in the savage night on the edge of the desert, shorelands, and river banks. They may have felt that this new evil was not something to be ignored from the oasis or thicket, but something that would change them, and that all mankind would have to come to terms with new restraints.

It is gratuitous to say that when man first developed an imagination, he was assured of true cultural development. Whatever cosmic rules govern the neurones and genes of our bodies, historians and those men with night-glasses trained to see in the full darkness of pre-history observe that man must learn by painful experience how selfishness leads to disaster, how cruelty is punished by suffering, and how hate is a virus of self-destruction. Charity and peace, with sound nutrition of a people, reward with happiness, longevity, and development. There has never been a democracy where there was a chronic lack of food! A starving man knows no reason and falls easy prey to the disruptive influences that have ever abounded in this world.

Whether these primitive, half-sedentary farmers were first pastoralists or cultivators is controversial, but some investigators assume that hoe cultivation came before stock breeding.

It seems apparent to us that wheat-barley and ox-sheep are the foundation foods of food-producing economies. The two cereals are highly nutritive, can be stored easily, show good yields, and are relatively easy to prepare for food, although grinding with the early querns was a laborious task for women. Cereals can be made into a variety of foods. Wheat and barley were easy to raise, with much spare time for other activities, as the Corn Belt farmer of the past generation was wont to say, as he observed the wheat production of the Northwest. Contrasted to the rice grower of the Orient, the Neolithic cultivator toiled lightly, and devoted some time to fishing and hunting before he was reduced to serfdom. Cultivation, in distinction from gathering, obviously lessens the need for large areas per capita. With more mouths to feed there were more hands to till, and children were useful in agriculture (but not in a hunter's life). When the idea of cultivation of cereals arose, diffusion was rapid.

The Magdalenian culture of the Old Stone Age was perhaps more brilliant and certainly more specialized than the cultures in the prairies of the Near East and the Valley of Egypt. The humbler southern folk, after the rain belts changed, still were collectors, and parasites on nature, but nevertheless took the decisive steps of sowing cereals, domesticating animals, and gardening. The worn Natufian sickle is conjectured to have been used for cutting self-sown grain, but experiments today show that harvest of self-sown wheats and barleys leaves little grain in the areas for the next harvest. The Natufian grains, however, may have possessed the tendency for self-sowing, like present-day hardy rye in Afghanistan, which behaves like a stubborn weed. Weeding and planting with stick or the crudest hoe appear necessary to insure a crop of sorts to be left by birds and ground animals.

The origins of palm, date, olive grove, fruit orchard, and grapevine (viticulture) cultivation, caring and pruning, are lost in the prehistoric period of the Iranian plateau and the three valleys. Obviously, these plantations anchored folk, and sedentary life became more necessary than it was in the case of cereal farming, as exemplified by the Iranians and Danubians. The importance of these foods in supplementing cereal and meat diets is apparent. The surplus foods would increase with increasing populations which the three valleys could amply provide with irrigation. Numbers of individuals and families could be released from the business of food production and engage in the secondary tasks of a village. Surplus food and manufactured goods could be bartered, and nomads

often served as middlemen. Certainly, the caravan and trade routes between the three valleys became numerous anastomosing channels.

Finally, as Professor V. Gordon Childe (1948, 1950) points out, it was discovered that men as well as animals could be domesticated, i.e., made slaves. Slaves might or might not be properly fed and the tradition of slave dietaries has plagued the so-called brotherhood of man right down through his literate period.

With growth of the villages and pooling of knowledge of the three valleys, the Urban Revolution (Childe [1948]) began, with centralization of power and sharp class and occupational distinctions (4000 B.C.). The State arose and deprived most of the people everywhere of their share of the fruits of nature. The roots of the present lie deep in the past. Civilization has left unsatisfied certain fundamental instincts of human nature.

Foundation Foods

Some of the tombs (royalty and upper classes) show the concepts of best nutrition of these early times. The cult of the dead supposed that the occupant of the tomb was on his way to mortal life and must be in possession of his earthly goods, food, and drink. He must have the best. In the early royal tombs of Abydos are found storerooms filled with jars of edible oils, beer, wheat and barley, fruits, vegetables, fish, fowl, eggs, and meat. The royalty, at least, ate the *Basic Seven Foods* (p. 52). The common folk had always murmured at their lot but did nothing about it except to say, "Canst live by bread alone, but canst live at all without it." There was a way up in social advancement, however, which is shown in an Egyptian document of New Kingdom times. A farmer writing to his son says, "Put writing in your heart that you may protect yourself from hard labor of any kind and be a magistrate. . . . The weaver in workshop is worse off than a woman; with his knees to his belly he squats and never tastes fresh air. He must give loaves to the porters to see the light," and so on for the smith, stone cutter, carpenter, etc., "who are worse off than the men who hack the ground."

The sudden surge of mental and physical vigor characteristic of the Old Kingdom of Egypt (2780 to 2280 B.C.) is not presaged by the modest archaeological picture of predynastic Egypt. The excellent dietary of that epoch has been invoked for partial explanation of the sudden efflorescence of the great pyramid age, but obviously the reasons for this sudden spurt of power are not clear.

Practically all of the inventions and devices of early food-producing times, pottery, sickles, rubbing-querns, planting-sticks, baking, fermen-

tation of beer and bread, planting, cultivating, reaping and storing of grains, and spinning flax were the work of women. The Neolithic Revolution, leading to civilization as we know it, can be accredited to Woman, who was also the first botanist. Whether or not she tried out a new plant for its edibility on her lord and master is not known, but brewing she did, and stimulated the representatives of the early gods, until by 3000 B.C. intoxicants were necessities for sage and serf, king, general, and tax collector. The millennium preceding 3000 B.C. produced more useful and important discoveries than any period until the Renaissance and the Colonial expansion period of Europe.

When the ox was trained to drag the hoe wielded hitherto by women, field cultivation began (3000 B.C. or earlier in the Fertile Crescent and 1400 B.C. in Sweden and China). Motive power for sledges and two- and four-wheeled carts in Hither-Asia came in before 3000 B.C. Pack-asses also relieved women's shoulders of their burdens, and by 2000 B.C. horses were in use in the South for driving. Camels furnished means of desert transport in the Second Millennium, and caravans went afar.

During the period of increasing aridity of Hither-Asia, the concentration of minerals in the soil and water of rivers, lakes, ponds, and some oases influenced plant and animal life both for good and evil, H. C. Brewer (1948). However, sunlight is one of the most important factors in regulating or determining the ascorbic acid (vitamin C) content of plant tissues, although other environmental factors appear to be less important in this respect. In an authoritative review of the influence of climate and fertilizer practice upon the vitamin and mineral content of vegetables and cereals, Somers and Beeson (1948) describe the major importance of sunlight time and intensity and the relatively minor importance of temperature (within limits of growth), carbon dioxide concentration, soil moisture, rainfall and minerals, all of which in optimum concentrations affect the amount of vitamin A, thiamin and riboflavin content. Variety of plant and climate in these respects was of more importance than fertilizers. The nutritive value of irrigated food plants in the sunny, semitropical areas of the three river valleys of Egypt, Mesopotamia, and Punjab must have been high, and monocultures of wheat-barley-rice would tend to furnish essential nutrilites in greater abundance than in relatively sunless areas of the North during the Early Iron Age, for example. While lime is needed for the plant and is protective for animals and man, the relation between calcium in soils and its transmittal to plants depends upon factors unknown at present. Nitrogen, potassium, gypsum, and manganese depress the calcium content of wheat, alfalfa, and kales on certain loam soils. Hence,

we are still at a loss to know the exact food values of plants of pre-history and in historical times, although our general picture of nutrilite contents of early foods can be derived from recent data. Sun-worship concealed a hidden factor.

The Neolithic Revolution—food production—ushered in a completely changed dietary both in the nature of foods and their preparation. Man for the first time in his long sojurn had at his disposal the basic foods which could be prepared together by cooking in pots, and later, swinging cauldrons, or prepared singly by various cooking methods employed today. The new foods or prepared foods were:

1. Cereals: wheats, barley, and later rye, rice, oats.
2. Fermented bread and beer with their yeast components.
3. Dairy foods: milk, cheese, soured whole milk, butter.
4. Fruits of many kinds.
5. Vegetables of many kinds, and root crops.
6. Poultry and eggs (hens introduced later from India).
7. Edible oils.
8. Spices, savoring agents for acceptability.
9. Meat supplies and fish and shellfish had been available in Paleolithic and Mesolithic times, but usually after a hand-to-mouth economy. Beef, pork, mutton, and eventually poultry became regular supplies, economics permitting.

Today nutritionists speak of the *Basic Seven* Foods to be eaten every day for buoyant health. These seven foods are also called *Foundation Foods* and consist of:

Green and Yellow Vegetables . . . some raw—some cooked, frozen, or canned—one or more servings a day

Oranges, Tomatoes, Grapefruit . . . or raw cabbage or salad greens—one or more servings a day

Potatoes and Other Vegetables and Fruit . . . raw, dried, cooked, frozen, or canned—two or more servings a day

Milk and Milk Products . . . fluid, evaporated, dried milk, or cheese—1½ pints to one quart for children; one pint a day for adults

Meat, Poultry, Fish, or Eggs . . . At least three or four eggs each week and one serving of meat, poultry, or fish a day

Bread, Flour, and Cereals . . . natural whole grain or enriched or restored—three or more servings a day

Fats, Butter, and Fortified Margarine . . . use for spreads and for seasoning every day

The *Basic Seven* Foods recommended to be eaten every day in North America may not be applied in some countries with good results. For instance, a large quantity of milk may be unsuitable. It is probably better to show how the nutrient content of staple foods can be improved and how the diet can be effectively supplemented by a few other foods of high nutritive value, Jean Ritchie (1950).

Resistance to changes of ancient food habits can be justified in case of Eskimos and Bush Indians of Canada and folk of other regions. It is dangerous to teach people to eat raw vegetables where night-soil is used for fertilizer. It is criminal to teach folk to drink unpasteurized milk or to eat certain uncooked foods known to be infected with bacteria, parasites, or other infective agents. Bush Indians, when living on white man's foods and intoxicants, copying his environment in the form of shacks in which numerous people live instead of the old wigwams, and contracting his diseases, develop appalling physical and mental conditions with high mortality rates.

India and China

The climatic phases of the Old Stone Age in India during the Pleistocene can be correlated with similar phases in Europe. No remains of skeletons of Paleolithic man have been discovered in India, but there are indications of flake tool-making men at the beginning of the Second Great Interglacial. Beginning with the Third Glacial and surviving later, core tools are found in southeast as well as central and western India. These industries of food gatherers appear to have changed very little until the end of the last glaciation, perhaps 10,000 years ago.

The Neolithic appears very late. The archaeologic record of India, meager at present, does not show clearly the Mesolithic and Neolithic processes seen to the west in Iran and Mesopotamia. Agriculture begins with the growing of wheat-barley. The pre-history of rice is obscure. The arts of agriculture came in from the west, perhaps Mesopotamia rather than Persia (Iran). There is evidence of Sumerian trade in the Indian Bronze Age peasant communities and the presence of western Indian merchants in Elam and Sumer of early dynastic times (2800 B.C.). Later, sea trade with the Indus River communities (Harappa) and Mesopotamia was established (2300 B.C.). Under the term "Harappa Culture" lies concealed one of the greatest nameless kingdoms of Western Asia, S. Piggott (1950). The ethnic units, according to the evidence from the skulls, were first the proto-Australoid type, then as now the underdogs, or exterior castes, then the Mediterraneans, contributing to the food producing and urban features, and a few Alpines and Mongolians.

These Indian city cultures with their radiating settlements came to an abrupt end (before 1500 B.C.) at the hands of burning and plundering invaders, a new people from the West. These invasions were not confined to India alone but occurred in Mesopotamia (Akkad, Ur), and we see the rise of the Hittite Empire of Asia Minor, disturbances in

Syria, North Persia, Russian Turkestan, Egypt, and Europe. It seems likely that these Aryan-speaking folk were a loose confederacy about 2000 B.C., stretching from South Russia to Turkestan. Their way of life is clearly presented in the Rigveda, the Homeric epics, and was much like that long afterwards described in Beowulf and the Irish Sagas. They were warriors growing some grain, but their herds of cattle and flocks of sheep and goats were their wealth. Their cows were milked thrice daily. Beef was freely eaten and their god Indra was a champion beef eater. The later Hindu ritual prohibition of flesh is connected with belief in transmigration of souls, a non-Aryan belief of the reëmerged folk. The Aryans generally, in their many regions of conquest, utilized the residual culture but added and adapted much of their own, as it is sometimes observed in case of Celts, Germans, Gothonics, Greeks, and Kassites of Mesopotamia. The horse above all was their domesticated animal, used as a chariot animal for racing and war (2000 B.C.), and was of the coloring (chestnut-colored head and back, and dun on lower parts) of the Prschevalski horse (p. 103). Not much is known of their houses or villages but there is a similarity in their wooden, rectangular, thatched-roofed houses in India, Denmark, Alsace, and Italy. They used swinging cauldrons and roasting spits, and *forks* for eating boiled meats. They ate breads and porridge. Their inordinate potations of mead (much later beer and ale) are well known and the word "mead" runs convincingly through all Indo-European vocabularies—Sanskrit, Greek, Celtic, Gothonic, and old Slavonic.

The Dark Ages of India ended sometime after 500 B.C., conceivably from stimuli from the West and perhaps from a blending of the surviving Harappa ideas and the Aryan ferment.

In the valley of the Indus and its five tributaries (Punjab), much the same processes of the Neolithic Revolution are seen as in the Nile and the Tigris-Euphrates valleys. The cities of Mohenjo-daro and Harappa are still impressive mounds. These folk ate much the same foods as other Neolithic peoples, but included flesh from zebu-cattle, hens, and elephants. Rice and wheat were their staple cereals. They ate no asses or camels. They wore cotton fabrics, not flax or wool, and used individual water-cups. They used bitumen, built two-storied brick houses, public baths, huge granaries, magnificent sewage systems and drains, and observed town planning.

This culture perished utterly, but Hindu and all civilizations are indebted to an unexpected degree to the Indus or Punjab civilization.

Long afterwards, as we have noted, the Aryan Hindus arrived from the northwest into the western tributaries of the Indus and to the sources

of the Ganges, living by pastoralism, cultivating cereals also, and by raising many cows and horses. They were warlike, led by their petty chiefs or rajahs, and addicted to strong drink, gambling, and horse-racing. The Aryan cultures were far-flung in the Ancient World by peoples, not a race. They are the ancestors of the Brahmans of India. These Aryans were a linguistic group only. Their languages, Sanskrit, Persian, Greek, Latin, Slavonic, Celtic, and Germanic or Gothonic, were descended from an obscure parent tongue and from a mythical people who can be identified only with reluctance, or not at all, from archaeological and anthropological data. Totemism was not normal in Indo-European (Aryan) societies, V. Gordon Childe (1935).

In the earliest settlements in India, about which all too little is known, wheat, barley, dates, and cotton were certainly cultivated and there is evidence that India grew pears, plums, peaches, apricots, grapes, pomegranates, sweet oranges, rice, ginger, mustard, melons, sugar cane, and millet during the Urban Revolution. Their food animals were humped cattle, unhumped shorthorn cattle, antelope and gazelle (which failed all over the Fertile Crescent, and India as well, to become domesticated), pig, dog, buffalo, sheep, and above all, the hen. India gave poultry to the world. Their taboos eventually excluded "all the hairy kind," i.e., ox, horse, ass, dog, fox, wolf, lion, monkey, and elephant. They drank fermented grape and sugar cane juice, and in the Bronze Age used only copper cups when sick. Dried fish from the Arabian Sea were imported into India during the Urban Revolution, and they traded with the jungle areas to the east. It is apparent that India, Sumeria, and Egypt all must have shared a common cultural tradition, each bequeathing much to subsequent cultures. They ground their cereals in saddle-querns, as did all early cereal eaters including the Natufian gatherers. Their cities are composed of many-roomed dwellings with stairs, and great public baths. They built with fire-brick, but no military walls, ramparts, or temples are found. The making of bullock carts, weaving, and pottery making were well-developed crafts. When their culture shifted from the Ganges, the cities were centers of wealth, pomp, and castes, and their great philosophies lighted their world and the world of the western peoples, as well. Their ancient occult time scales, arrived at then and extended to 1950, show the earth came into existence 1,972,949,050 years ago, which has recently been the most favored estimate by the physicists and geologists. There have been many bands of migrants from India who, through taboos, have abandoned or failed to use the chief food animals of agriculture. Likewise, conquering intruders of prehistoric and historic India, as well, have experienced radical food changes in their new environment.

In Nutritional Reviews (6, 1948, 157, 181; 7, 1949, 252; 8, 1950, 334; 9, 1951, 213) the nutritional requirements in modern India are surveyed. Diets in India are composed chiefly of cereals. The nutritional requirements of these people differ from others in their ability to maintain nitrogen balance on their cereal-protein and vegetable intake (rice, vegetables, and some wheat). They apparently have sufficient protein from these vegetable sources. Perhaps through selection and response they are able now to maintain nitrogen equilibrium and therefore "meat" protein is not a problem with them, although we doubt this very much. Collumbine (1950) observed that the proteins of polished rice were more available than in unpolished rice and his test subjects appeared to maintain nitrogen balance better on polished rice than on unpolished rice. Apparently deficiencies of niacin and ascorbic acid do not appear to be problems in their nutrition.

Deraniyagala (1940), in his study of the Stone Age and cave men of Ceylon, found that their diet was almost entirely composed of meat of extinct mammals, snails, and crabs. Their tools followed the Paleolithic patterns.

The Neolithic Revolution in China appeared before 2000 B.C., in the valley of the Yellow River where cattle breeding was practiced and cereals grown. By 1400 B. C. the great city of Anyang was essentially like those of Sumeria and India. Pigs, cattle, sheep, and goats were raised, as well as water buffaloes, chickens, and ducks. Rice and millet were the staple cereals and silk was woven instead of cotton or flax. Trade goods came in after 1400 B.C. from Greece, Asia Minor, and northern Iran, on the caravan route across Asia, used until the age of railways. It appears that China has long suffered from lack of food and perhaps choice of foods.

Dr. H. C. Hou of Nanking (1949), in his survey of nutritional diseases in China, found that the Chinese diet is low in fat, vitamins, animal protein, and calcium (lime). He believes these insufficiencies in calcium and protein over generations may account in part for the short stature of the Chinese people. Beri-beri was known from 1000 B.C. in Chinese literature, when rice polishings were not eaten. Also, people eating raw fish as in South China suffer depletion due to thiaminase, an enzyme of some fish which destroys vitamin B_1 (thiamin). Lack of vitamin A, causing night blindness, was described in China of 610 A.D., according to Dr. Hou.

Primary liver cell tumors (hepatomas) are not often seen in well-nourished populations, whereas in poorly fed rice, corn, and millet-eating peoples of the world the incidence of hepatomas is relatively high

(Nutrition Revs. 9, 225, 1951). The composition of foods used in Far Eastern countries has been given ample study by Leung, Pecot, and Watt (1952), to whose work the student is referred.

The New World

It may not be out of order at this point to mention the food contributions of American aborigines, which influenced so profoundly the history of the modern world, both nutritionally and economically. Many nutritionists state with justice that native American foods brought about an epoch after 1492 comparable in importance to the food-producing revolution. Scholars of the Americanist school and Orientalists have with much "inkshed" belabored each other, but the historical fact still stands that the monoculture of the masses in the Fertile Crescent might have resulted as disastrously as the monoculture of maize in Italy, Spain, the Danube, Balkans, and southern United States after the introduction of corn foods. In 1574 the German traveller, Leonhard Rauwolf, found the lands of the Euphrates covered with fields of New World corn. The deficiency syndromes of pellagra in all manifestations loom large in the medical history of the countries just named. The Aztecs, Mayas, Incas, Iroquois, and most American nations carefully supplemented their corn diets with fish, game, fowl, guinea pigs, squash meal, bean meal, sweet potatoes, sweet and red peppers, nuts and berries. They had learned their lessons in nutrition the hard way and showed the early colonists methods of preparation of corn foods, warning them that these foods should not be eaten without fish or game.

Wheat and the foundation foods were available in the Fertile Crescent (Nile to the Indus) and whole wheat furnished essential amino acids (lysine, tryptophane) and the vitamin niacin to an extent that maize could not. Aside from frank nutritional deficiency diseases, Cannon (1949), in his experimental observations on dietary protein and antimicrobic defense, found that dietary protein is important whenever severe protein deficiency has depleted the tissue protein stores and thereby impaired the body's capacity to activate the mechanisms of both natural and acquired resistance. Protein stores in the body are "bulwarks against infection."

The preparations of corn (maize) for food were numerous, varying with tribes and nations of Indians, and later food manufacturers and processors. When maize through long selection by these ancient folk reached the edible ear state, the ears were pit-roasted and the roasted ears not eaten immediately were dried for further use. Also, the matured hard kernels were parched, milled by hand, and the meal made into

mushes, cakes, pones, wafers, and bread. Wood-ash lye and lime were used to treat corn to remove the skins or horny envelope and the corn was boiled (hominy) thus supplying much needed calcium. Corn liquor and beer were unknown to them. The fermented drinks of the Pina and Southwest Indians were made from cactus fruit.

There was complete absence of dairy foods in pre-Columbian America. The Amerinds, unlike their racial kinsmen of Asia, did not domesticate animals, except the dog and llama. The Aztecs bred several varieties of dogs for food, as well as turkeys, their chief domestic fowl, although they raised some geese, ducks, and quail. Birds, hedgehogs, fish, and other small animals were baked in clay and the clay removed after baking.

The Spaniards under Cortez, during their first days in Mexico City, noted Aztec foods like fruits, fowl, vegetables, many kinds of meats, corn, cakes made from fly eggs; and restaurants and stalls where were sold tortillas, chili stews, chocolatl, honey cakes, pulque (maguey plant juice), oranges, bananas,[1] strawberries, guinea pigs, and dogs. The peanut, *Arachis hypogaea,* had been grown in America since about 950 B.C. It was introduced from Peru into the Orient, to Africa, and back to the United States with African slaves. Barnum's circus and street vendors were responsible for its popularity in America, and the peanut has also found a wide range of usefulness in industry and commerce, E. P. Tappey (1943). Of the 3,500 different species of plants known to have been used by the Indians in America, either for food, beverages, fibers, medicines, dyes, or utensils, nearly one-half was used for food.

Many of the Indian remedies were not good curatives, but 45 of these species have been at one time or another official medicines listed in the U. S. Pharmacopoeia.

We have not the space here to dwell on the potato, but the common potato has exerted an influence on nutrition and history ranking in importance with corn. Old World food economies were changed drastically when the potato caught on as a staple food. The potato was considered a lowly food by Europeans, but it was rich in energy, vitamins, and minerals, as the robust Irish, Scandinavian, and German folk proved.

It would require a volume of bulky dimensions to do justice to the contributions of the American Indians to world betterment. We list all too briefly these contributions: maize, potatoes, tomatoes, sweet potatoes,

[1] Cultivation of the banana is recorded in the Malaysian area probably as early as 2000 B.C. Historical sources state that bananas were introduced into the Caribbean Islands and Mexico after 1516, by Friar Tomas de Berlanga who carried seedlings from the Canary Island. The fruit is native to the Far East and Pacific Islands.

squash, pumpkins, turkeys, cranberries, peanuts, Brazil nuts, chocolate, black walnuts, pecans, vanilla, maple sugar, wild rice, kidney and lima beans, chili, pineapple, avocado, cashews; drugs like quinine, ipecac, cocaine; a variety of cotton and alpaca wool; cassava from which is derived tapioca (manioc, farina, etc.); mixed cookery of new foods; rubber; a number of useful devices like moccasins, snowshoes, toboggans, bulb syringes, boats, parkas, etc.; and above all, tobacco. While medical historians believe the weight of evidence points to Central America or the Caribbean islands as the focus of syphilis, the occidental folk supplied Amerinds with a host of diseases in return, which were contracted under more austere conditions.

CHAPTER VI

The Neolithic Fayum

There is a Neolithic village-site, several sites in fact, to the west of the Nile Valley where the Sahara rolls on in desolate sand and rocky hills at an elevation of 650 to 1,000 feet above the river. Close to the Nile Valley, 60 miles below Cairo, a gap in the western hills leads to a great depression about 40 miles across each way in the Libyan Desert, shaped like a maple leaf with the stem pointing eastward to the river. In Paleolithic times there was a double lake at the 222-foot level and Mousterian-Levalloisian hunters lived in the well-watered area until both lakes and men vanished in geological time. A second lake, about half the size of the Pleistocene lake, formed during the last Pluvial. The lake—Birket el-Qarun—is now 140 feet below sea-level and quite brackish.

In 1901 C. W. Andrews discovered the Fayum fossils thought to represent ancestors of existing mammals, including whales, and predicted that early forms of anthropoid apes would be found there. Schlosser verified this in 1911. Chiefly through the remarkably fine work of the English archaeologists, Caton-Thompson and Gardner (1934), a clear picture of primitive agriculturalists is available, although the Fayum material is already very complex and may show contact with the Neolithic of Capsian tradition, Linda Braidwood (1946). In none of the sites here or elsewhere is there yet clear evidence for the transition to the food-producing revolution. The industries do not presage the sudden appearance of village culture materials. The mortar and pestle, for instance, found in early Capsian traditions may have been used for preparing coloring matter and may not imply grain grinding at all. However, our interest in Fayum lies in the fact that these folk were living under conditions similar to those under which the first agriculturists did live, i.e., they grew wheat and barley, killed game, fished, ate mussels, and raised some domesticated animals for meat. Associated in some manner with these lake dwellers were the Neolithic Badarians, whose settlements show ritual burial of cattle and sheep, and the Merimdians of the Nile delta, who are contemporary with the Tasians. Badari near Assiut, Merimde, Tasa, and Fayum were already established before desiccation of North Africa had deprived the Nile Valley of heavy timber. Roots of large trees have been found in the Badarian Neolithic villages. The Sahara was then drying rapidly, but in Paleolithic times had supported a relatively dense population of hunters and gatherers, Forde (1949)

The Neolithic settlement of Merimde-Beni-Salama was uncovered by Junker, Menghin, and Scarff. This village possessed streets. The Fayum A settlements of Caton-Thompson and Gardner (1934) were associated with the 10-meter lake and characterized by a relative wealth of finds, compared with Fayum B, associated with the four- to two-meter lake, characterized by a poorer industry and no pottery. Both settlements may have lasted 800 years. Elise J. Baumgartel (1947) regards the dating of Fayum A and Merimde as Sumerian and predynastic of Egypt, but carbon-14 dating may yet aid in untangling the *chevaux-de-frise* of pre-history. Arnold and Libby (1950, 1951) show the uncarbonized wheat of the silos of Upper K, Fayum A, Pit Number 13 to be 6,095 ± 250 years old by radiocarbon dating. Later Dr. Libby (1951) found the wheat and barley in Upper K, Pit 59, Jar 3 to be 6,391 ± 180 years old.

Neolithic man came to the Fayum basin perhaps 6,000 to 7,000 years ago, at a time when the waters were again falling. Caton-Thompson and Gardner (1934) correlated their finds generally with lake levels, so that sequence is correct in their studies. Fayum man was both an agriculturalist and hunter, evidently coming from the East, for he was "a graduate of the earliest and perhaps the most momentous school of primitive civilization, that of the agriculturalist." The lake silts were fertile and by hoe culture the Fayumis became settled in one of the "oldest typical settlements studied." Some time before, the basin was flooded by the Nile, and rainfall seems not to have played a significant role in maintaining levels thereafter. The Nile branch silted up while the lake-level sank. Herodotus (450 B.C.), who saw Lake Moeris, as it was known in his day, mentions its 140-foot level and in the time of Ptolemy Philadelphus it had shrunk to its present salty trough, 25 miles long and a maximum of six miles wide. The artificial canal connecting with the Nile, begun in the 12th Dynasty and completed by Amenemhet III, finally reclaimed about 27,000 acres and became a seat of royal life of that age, Breasted (1931).

The Neolithic settlements were made on recently flooded ground close to the lake. The villagers did not need to venture far to hunt, because game came to water. The lake teemed with crocodiles and hippopotamuses. There were elephants, gazelles, wild and domesticated pigs, and carnivores. The great cats did not encourage extensive livestock raising. The Fayumis were expert bowmen, set fish traps, drew nets, and also fished with hook and line. The arrowheads found in elephant ribs raise the question of poisoned arrows, when one realizes the questionable efficacy of arrows in modern elephant hunts. Arrow

poisons like curare would have to come by barter, which is not likely. On the basin island were found spearheads like the Danish forms, and also a flint dagger 9.4 inches long, superbly made and identical with Danish work which was to appear afterwards in the North.

The village "Kom K" was an oval-shaped mound 400 by 200 feet, indicating that the site was an island when the lake was full. About a mile away was another site, "K," where on a ridge behind these sites were found the granaries which belonged to both settlements. Grain growing was carried out on a relatively large scale on the recently emerged fertile strips. Caton-Thompson and Gardner (1934) believe it possible that these Fayumis devised a simple irrigation system, whereby the lake water was canalized from the little depressions which indented the shrinking lake shores.

Both Professor Coon (1939) and Professor Childe (1939) suggest that these Neolithic farmers, when they abandoned Fayum, moved west along the North African Coast and up through Spain (El Garcel), spreading rapidly their new food-producing economy to the Swiss lakes, and western and northern Europe. El Garcel and Ertebolle pottery are strikingly alike. Although they did not influence Egypt, they were markedly important for Europe. They were probably blond, with larger dolichocephalic heads than the negroid predynastic Egyptians, since an Egyptian portrait of the daughter of Cheops, builder of the great Pyramid, shows a definitely blonde woman with bright-yellow hair and white skin. The Libyans inhabited the north coast of Africa to the Delta and are painted with Nordic features, blond hair and fair skins. Blondism belonged to the Delta rather than to Egypt proper. Naturally, blond folk or the lighter whites came into Europe from many other, more important sources. The Fayum and Merimde settlements of wattle and daub huts were suddenly abandoned, but the later Nile settlements flowered into the civilization of Egypt. Libya was rich in vineyards, olive trees, and cattle until the end of the second millennium, B.C.

There was an abundance of reeds, rushes, and grasses for the villagers, but the wood seems to have been only tamarisk, an evergreen shrub, which stresses arid conditions to the archaeologist.

Their egg foods were fish roe, eggs of turtles and crocodiles, and enormous numbers of ostrich eggs were eaten, according to the evidence. An ostrich egg contains in volume six hens' eggs and an ostrich nest may contain about two dozen eggs. This thick, durably-shelled egg with air sac up was perforated and placed on hot embers, the egg magma being stirred with a stick until done. The Egyptians of later date tell a

typical humorous story of a noble bird fancier who found a strange egg on the lake's banks. He took it home and carefully incubated it in his poultry house. The egg hatched into a crocodile, which promptly ate up all the poultry on the farm.

Their flesh foods, according to the evidence, were sheep, goats, oxen, pigs, hippopotamus, dogs or jackals, turtles, and elephants. A camel's-hair cord found there may be of later date. R. Uhden (1929), in his history of the camel in North Africa, believed the introduction of the camel could be generally dated from the Persian conquest of Egypt. However, the camel is represented in rock pictures in widely separated localities dating back to 2270-2000 B.C. Animal husbandry may have been difficult because of the large cats, and Caton-Thompson and Gardner (1934) note the curious absence of sheep or goat dung in the settlements, in contrast with those of the Nile Valley predynastic. The caprices of discovery usually leave much to be desired, but in addition to the protein-rich foods mentioned, several varieties of fish, snails, and mussels were eaten. These Neolithic Fayumis, when they departed, bequeathed a grain culture assemblage of great interest. Caton-Thompson (1934) found 165 silos at the sites, lined both with adhesive dung-mud and with coiled straw matting of wheat and barley straw. Many of the silo pits contained remarkably preserved grain, always mixed wheat and barley, the ratio of mixtures varying greatly. There were also a few seeds of *Linum* (flax) and *Polygonum,* as well as husks and spikelets of the grains. The silos were sunk in the old dry, high-level gravels which, because of wet fields, account also for absence of burials in the settlements proper.

The wheat is emmer, *Triticum dicoccum,* and the barleys are six-rowed *Hordeum hexastichum* and *H. vulgare,* together with two-rowed *H. distichum.* According to Dr. A. E. Watkins (1933) and Dr. Naum Jasny (1944), *Triticum vulgare,* the common bread-wheat of later times, was not known for a long time, and is almost a stranger to the Mediterranean area. Hoe tillage was employed and the grain was cut with sickles. Two sickles 20 inches long, among those found, were made of tamarisk wood with flint blades inset in resin, just like the Arunta of central Australia today use resin and beeswax for hafting flint points and blades. A surprisingly firm set is effected by this primitive method. The Fayum resin, when tested by burning a little of it, gave off a terebinthic odor.

The grain was ground on saddle-querns, which do not differ greatly from the Egyptian Old Kingdom querns and saddle-querns, also found elsewhere in both the Old and New Worlds. We can infer that the

ground grain was roasted on hot stones or mixed with water to form a paste, which could either be made into a porridge or spread thin over hot stones and baked into a cake or sheet. Porridge and flat, unleavened breads remained on the menu for many centuries. Jacobs (1945).

Bread making described in the Mesopotamian Epic of Gilgamesh was conducted as follows: "First was collected his meal (wheat, barley), next ground, and then it was moistened. Fourthly, she kneaded its dough, and it was baked." The ovens consisted of small domes of bricks heated from within by wood fires. When the interior was hot, the dough in form of flat pancackes was thrown against the inside wall (through a hole) to which it adhered until baked. Dates and sesame were often mixed with the flour.

The fire holes sunk by the Fayumis for cooking-pots contain fish and mammal bones, and the charcoal from the fuel points to tamarisk wood, not dried dung. Tamarisk provides the desert's best fuel, burning with a hot, shining blue flame that resists wind, without crackling or flicker. Dung was used for the silo pit adhesives, as in India, and also as a field manure. The barleys were the same varieties cultivated in modern Egypt. A long time must have elapsed to develop the barley of the Neolithic.

Their cloth was woven from flax, and leather was also used, as well as straw grain-baskets for sowing. The cooking-pots and utensils of Merimde and Fayum are closely related in primary style, and close cultural links with Merimde are attested in tools and fabrics. They may have used sinew and fish glue, made jewelry, maces, needles, bone harpoons, and a variety of stone, pottery, and basket containers. Apparently they did not brew beer or use any fermentation processes. They used ocher cosmetics, but not the malachite pigments of the later Egyptians.

Naturally, the Fayum wheat was tested in the laboratory, as Caton-Thompson and Gardner (1934) point out, probably to lay the ghost of fertile "mummy wheat." While the daily press often prints stories of ancient Egyptian mortuary wheat sprouting and growing when planted, we reluctantly cite a few experiments in this connection. Raffaele Cifferi (1942) in his paper, "A British Fraud to the Detriment of Cosimo Ridolfi," writes that in 1853 Marchese Cosimo Ridolfi, a well-known Florentine agricultural scientist, received mummy wheat grains from the British Museum, which grew well and were honestly thought to be grains from Egyptian sarcophagi. "Ridolfi was a victim of a swindler, probably not a fellah, but a guardian of the British Museum."

In 1879, W. J. Beale collected 20 different kinds of seeds, and testing samples were taken every five years for 40 years. After 40 years, 50

per cent of the seeds sprouted. J. W. Duvel (1924) in 1902 buried 107 species and found 69 grew after 10 years, 20 after 20 years, but most of the seeds were weeds. Cereal, legumes, and seeds of cultivated plants failed to grow. A more ambitious project was carried out by Becquerel (1906), who tested 550 species of seeds which had been stored in the Jardin des Plantes, Paris, for 24 to 135 years. No seed over 80 years old grew, and a few wheat seeds were viable for 50 to 75 years. Fertile mummy wheat comes from recent crops, although lotus seeds may survive in a viable state for a long time.

One of the phenomena observed in the wheat and barley from the Fayum silos was carbonization, "lignification" or charring of the grains. Carbonization occurs constantly with finds of early cereals but not in all silos! Carbonized and uncarbonized grains occur in the same silos. Carbonization is not of fire origin. The grains are not lignified. Many theories have been invoked to explain the phenomenon, among which are anaerobic bacterial action, spontaneous heating like the heating haypile, continuous but slow enzyme activity over long periods of time, selective presence of metallo-catalysts like copper, cobalt, etc., and selenium absorption. Recently Robertson and Milthorpe (1948) found that stored wheat when infested with certain insects forms large amounts of carbon dioxide, and that insect infestation (Rhizopertha) produces "hot spots" causing wheat to heat. Wilson (1949) also observed that insect infestation is heavy on the surface of the grain and light or absent in the bulk. Where the temperature is initially warmest, the wheat heats most. According to Carter and Young (1950) dead, moist wheat infected with *Aspergillus* molds also heats most. A personal examination of carbonized hickory nuts, butternuts, beans, corn and cobs found in Adena and Hopewell culture sites led us to view carbonization as a dehydrogenation, not oxidation.

CHAPTER VII

Cereals

Agnes Chase (1948) in her article, "The Meek Shall Inherit the Earth," wrote, "Of all plants the grasses are the most important to man. All our breadstuffs—corn, wheat, oats, rye, barley, rice, and sugar-cane—are grasses. Bamboos are grasses and so are the Kentucky blue grass and creeping bent of our lawns, the timothy and red top of our meadows."

When a Brazilian chief of the aboriginal folk was given a box of matches by the German, Dr. Von den Steinen, he said, "We must plant these useful things." The Massachusetts Indians when possessed of gunpowder for the first time, fortunately for the little Plymouth Colony, "planted" the explosive but the "green touch" so often invoked by amateur gardeners was not vouchsafed them. When the natives of the Marquesas in the Pacific first met Europeans at the end of the 18th century, they admired metal which they had never seen before, and stole nails which they planted in the ground to bear metal fruit. The instinct for agriculture appears deep seated.

We have seen the golden plots and fields of wheat and barley in the Fertile Crescent [1] and its marginal lands. The best opinions place the original dibble stick-hoe cultivated fields in the now backward countries of Iran-Iraq, although Dr. C. O. Sauer (1947) shows that root digging was unplanned tillage. The Russian botanists who, a few years ago, went into the countries where Food Production economics originated, and elsewhere, found Hither-Asia, Egypt, North Arabia, and Abyssinia to be veritable museums of ancient cereals. Hulled einkorn was found cultivated in central Asia Minor and Asturia, but as a weed extended from Spain and Morocco to the Caucasian Mountains. Emmer was grown in the central Volga region, Abyssinia, France, Morocco, Greece, Germany, and India. Traces were found in all the Mediterranean countries. Spelt was not found in Turkestan, Afghanistan, Iran, Asia Minor, India, Mongolia, or the Mediterranean countries. The eight great centers or origins of cultivated plants delineated by N. I. Vavilov (1951), a martyr of genetics, are Iraq-Iran, Ethiopia, China, India, Peru, Mexico, and the southeastern Mediterranean-Caucasus area.

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[1] Beginning with Egypt and extending through Palestine, Syria, Mesopotamia, and thence eastward across oases and mountain slopes to the Indus river and Punjab of India.

Wheat

Einkorn is and has been of poor quality and low yield, but emmer wheat was well adapted to irrigation or inundation cultivation of the valleys of the Nile, Tigris-Euphrates, and Indus. Emmer needs water in early growth, but can withstand much drought in the later stages. This is also true of the spelt groups. Emmer dominated the early valley civilizations and Neolithic villages from North Africa to India, while einkorn was of importance only in Asia Minor. Spelt was not grown until the end of the Classical Era.

Schiemann (1940) believes the evidence points to a western Asiatic origin of original species and varieties of wheat. Dr. Naum Jasny (1944), in a masterly discussion of wheats of classical antiquity, has clarified the great confusion in classical nomenclature as to species and varieties of wheat, history, uses, and botany, and has aligned the whole subject according to modern scientific principles. The origins are, of course, unknown, but the controversy is mild at the present time. Even Dr. Vavilov, who originally believed that emmer was of Abyssinian origin, now places emmer in Hither-Asia, einkorn in Asia Minor, and spelt in Afghanistan.

Peake (1928, 1939), the English student of grain, concluded, however, that emmer arose in southern Syria and Palestine. We have seen that the Natufians of Palestine, who may or may not have been food producers, harvested emmer. The western Great Lakes Indians harvested wild rice and the western Indians harvested seeds of wild grasses much in the same manner, it is conjectured, as did food gatherers in Natufian times. Recent experiments would indicate that harvesting self-sown wheat-barley mixtures would deplete the supply seriously and that some sort of planting is necessary to gather cereals year after year.

Wild emmer was found growing a few years ago on Mount Hermon in Palestine, einkorn in North Syria, and spelt in South Turkestan. The Babylonian word for wheat, *buttuta,* and the Egyptian, *botet,* are indications of a common eastern origin.

Dr. Jasny (1944) suggests that spelt came down to the Mediterranean from the North before the Classical Era. Spelt is a comparatively young form, but einkorn and emmer were wild grasses in the late Pleistocene. Bews (1929) observed that it is in the relatively unchanging types of habitat that ancient types of plant forms are found most frequently. Paleobotany shows grasses as fossils in Cretaceous and Eocene times, similar to our modern hygrophilous reed grasses. The most advanced grasses are those adapted to the most adverse conditions. This is in accordance with the Russian advances in grain growing. The

Russians succeeded in growing selected cereal plants in the Siberian tundra, with its deep permafrost. [However, see L. Volin (1951).]

A great deal of work on genetics of wheat is being done in Russia and North America. One example from a voluminous literature, a study by Allard (1949) on the cytogenetics dealing with the transfer of genes from *Triticum timopheevi* to common wheat by backcrossing, shows how wheat can be bred for desired characteristics like stem and leaf rust resistance, and mildew resistance.

At this point we may mention briefly that wheats are classified into three broad groups, based upon their number of chromosomes, namely 14, 28, and 42. The generical name for wheats is *Triticum* (Latin verb, *tritere,* to grind, thresh, in use for 2,000 years). There are numerous varieties of wheat which have been developed in recent times. The naked and hulled wheats can be represented as follows:

TRITICUM (Wheat)

I. Einkorn—14 Chromosomes
Hulled: *T. monococcum,* one kerneled
Naked: None

II. Emmer—28 Chromosomes
Hulled: *T. dicoccum,* two kerneled, "emmer"
Naked: *T. turgidum,* poulard or English
T. durum, durum
T. polonicum, Polish (not grown in any quantity)

III. Spelt—42 Chromosomes
Hulled: *T. spelta,* spelt
Naked: *T. vulgare,* bread-wheat
T. compactum, club
T. sphaerococcum, dwarf

As noted before, an enormous amount of scientific work has been done in crossing species of cereals, and in investigating the genetical behavior of the hybrids. These studies have thrown much light on the origin of bread-wheats. *T. vulgare,* or common bread-wheat, may have come from emmer, while *T. persicum,* or Persian wheat, is a black awned spring wheat—a link between *T. vulgare* and the Afro-Mediterranean wheats. In 1914 Tschermak found in the Greek Theatre at Palermo, Sicily, and also as a weed along the Appian Way near Rome, the wild *T. villosum,* or *Secale villosum.* It was used as a male cross with *T. spelta* and other wheats. These wheat-rye hybrids throw important light on the relationship of the cereals (emmer, einkorn, spelts, and oats). From some of these crosses has come evidence that cultivated oats were derived from the weed, wild *Avena fatua.* The assumption

that a wild plant is brought into cultivation in its indigenous area may be, Forde (1949) reminds us, the "Botanist's heresy," since there has been an almost global distribution of vines, tubers, fruits, and grains.

It is thought by some botanists that a small wild spelt *(T. ailgilopoides)* found in Greece and the Danube valley may have been developed into *T. monococcum,* or einkorn, a one-grained wheat differing from other cultivated wheats by its slender stalk and pale-yellowish-green color. It is prehistoric in origin, but is still grown in Spain as fodder. "Wild emmer," *T. dicoccoides,* is still found in Palestine and Iran, whereas *T. dicoccum,* the cultivated emmer of pre-history, was the chief cereal in early Babylon. Today there are about 40 varieties grown in Russia, Abyssinia, and India. *T. durum,* or "macaroni wheat," is grown in the Old Black Earth region of southern European Russia. *T. compactum,* "dwarf," "club" wheat is Neolithic in origin and *T. spelta,* "spelt," "dunkel" is the hardy wheat of early Gothic origin. Common bread-wheat, or *T. vulgare,* of which there are over 26 varieties and a vast collection of mutants and hybrids, seems not to be found in Neolithic times of the South.

Prior to the Bronze Age, according to F. Bertsch (1939), the only wheats grown were *T. monococcum* (einkorn), *T. dicoccum* (emmer), and *T. compactum* (Zwergweizen). All wheats were often grown in mixtures and upon immigration into the northerly regions from the Fertile Crescent, or owing to changes in climates, hardy forms and other grains contained as "weeds," and natural crosses survived in the new fields. Rye and oats originally spread as weeds and mimics in wheat fields, coming into cultivation where wheat was not able to survive.

The early crops in the dawn of civilization were wheat, barley, rice, soybeans, flax, and cotton. Durum (emmer) was the principal wheat of the lands of Neolithic beginnings and through classic antiquity. During these times wheat had only barley as strong competition for acreage, but we often see, for example at Fayum K, mixed cultivation in the earliest food-producing times—either by design, ignorance, or carelessness.

While there is no transition yet existing in the archaeological record, from the Natufian to the earliest known village culture in Palestine (Jericho), a cave, Mugharet Abu Usba on the Palestinian coast, excavated by Stekelis in 1943, was thought to show transition to the food-producing stage. The Natufians with their grain-cutting tools may not have grown cereals, although W. F. Albright (1949) believes they were hoe-cultivators. Elise Hofmann (1928) found well-developed grains of *T. compactum* and seed coats of hemp in caves and mounds

which she dated as Paleolithic! The Paiute Indians were harvesting seeds of wild grasses and perhaps the Paleolithic folk did the same. Analyses of kernels of wheats show that Neolithic, Bronze and Iron Age wheats ordinarily were smaller kerneled than the present-day wheats of commerce. In Egyptian times and through Roman times in Egypt, durum and some poulard were the only naked wheats. Spring- and fall-sown wheats were carefully described in classical times. In Egypt, planting time came after the inundation of the Nile. The Greeks grew hard wheat as a fall-sown crop and soft wheat as a spring crop. Spring wheat was not much grown in Syria, Palestine, or Roman Africa. Fall-sown wheats were cropped in North Italy and North Africa. The hulled varieties of wheat are as good nutritionally as the naked, but man took advantage of naked wheat by selection, although oats and rice never yielded to his will in this respect.[2]

At Karanis on the northern border of the Fayum to the east of Lake Qarun in Egypt, the University of Michigan expedition found 17 samples of wheat belonging to the end of Roman times (third, fourth, and fifth centuries, A.D.). They identified the wheat as durum. There were no other wheats present. The ancient Jews grew only durum. The *tare* of the Bible is darnel, or rye-grass *(Lolium temulentum)*, of European grain fields, which is poisonous to cattle owing to a fungus which it harbors. Common breadwheat *(T. vulgare)* is not found in the wild state and was probably a chance hybrid formed by crossing emmer, einkorn, and the wild goat-grass, *Aegilops squarrosa*, which grew in the Fertile Crescent lands and still grows in Mesopotamia. After the autumn crocus alkaloid, colchicine, was shown in recent years to effect chromosome doubling, it was possible to show experimentally that emmer (28 chromosomes) and *A. squarrosa*, a noxious weed, produced the world's most valuable crop plant, *T. vulgare* (42 chromosomes), thus verifying the theory of the English wheat expert, John Percival (1921), who long ago believed bread-wheat to have originated in this way. Sweetness of wheat is found only in emmer, but parboiling increases the sugar contents of practically all wheats. Areas of little moisture produced harder emmers. The saturated Egyptian fields produced softer emmers and the later bread-making art may have brought on the need for softer kerneled emmers.

Brace, the wheat peculiar to the Gauls, was a spelt. From the Gallic term *brace* comes the French word *brasserie*, brewery. Brace was well adapted for brewing beer and for bread making. The Swiss lake sites

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[2] A large seeded hull-less oats *(Avena nuda)* is found in China. This variety originated in prehistoric China.

show *T. compactum.* Emmer was found in Sumeria before 3000 B.C. and einkorn in earliest Troy. G. Hatt (1937) summarizes the findings of grain impressions on Danish Neolithic pottery as 288 impressions of emmer, 46 of spelt, and 21, einkorn. Barley was also found. Emmer was found in Neolithic China (2000 B.C.). Suffice it to say that in 1949, 1,000 million bushels of wheats were grown in North America alone! Aurelius Victor stated that under Augustus, 48,115,000 bushels of wheat were imported from Egypt for four months' use in Rome; 144,345,000 bushels were needed for the annual supply for an estimated population of Rome of just under two million.

In the sections on poisonous foods and malnutrition we shall dwell on the wonderful dispensation of Providence—that wheat, instead of corn (maize), was man's staple cereal in the dawn of civilization, else the nutritional pattern could have precluded the culture forms that excite the admiration of students who know the roots of the present lie deep in the past. The wheat plants were not indigenous to the Americas, and wheat was not transplanted to Peru and Mexico until shortly after 1530. The red and white *vulgare,* durum, and poulard have shown no significant differences in their new habitats now for 400 years. An interesting observation was made by Captain Pierre La Verendrye, a French officer who visited the partly blond Mandans living in six large fortified villages on the Missouri River in central North Dakota in 1738. He reported large *wheat* fields on the river bottoms and distinguished carefully between the Mandans' supply of *wheat flour* and corn meal (South Dakota Historical Collections, **7,** 323-348). Holand (1946) shows with good evidence that Mandan culture was derived in large part from the Paul Knutson expedition of 1362 A.D.

The use of wheat is and was considered a mark of a high stage of culture, Maurizio (1927), but variety in certain foods is now known to be far preferable and is the test of a superior civilization. The differences between the modern diet and the foods of classical antiquity are a result of new foods of the Americas and new feeds for cattle, hogs, sheep, and other food animals, all produced in abundance.

Nutritional Aspects of Wheat

Whole wheat contributes a substantial amount of the protein needs of the diet. In 225 gm. of flour there are about 22 gm. of good protein, or nearly one-half the daily allowance. Whole wheat contains more protein than white flour and its protein has a higher biological value, Maynard (1943). Corn contains only one-fourth the amount of niacin found in wheat. Thiamin in stored wheat remains fairly constant, K. C.

Hammer (1949). There are marked differences, however, among the different varieties of wheat in the nutritional value of their proteins. Some wheats are low in lysine. In comparison to wheat protein the zein of corn lacks tryptophane and lysine, but in rat tests zein is not well digested, hence chemical analysis must supplant feeding tests for the true picture of nutrition. Hybrid corn with a high protein content has been developed and work is under way to breed corn with a higher content of the pellagra-preventing vitamins of the B complex, especially niacin, which is now present in too small amounts.

A sequence of nutritive values of proteins from greater to lesser values is beef muscle, beef liver, beef kidney, soya, milk, wheat, oats, barley, rye, navy beans, peas, and corn. Perhaps such studies have not been sufficiently standardized to permit significant comparisons from the data of various laboratories. Since practical nutrition deals with the diets, not individual foods, the classification of a single food may be of little significance today because of supplementary relationships. Block and Mitchell (1946) list biological values of proteins in human nutrition as follows (chemical score = 100): egg 100, fish 72 to 95, crab 72, beef 71, milk 78, soya 49, oats 46, rice 44, wheats 37, corn 28, and peanut 24. Dr. H. H. Mitchell (1952) concludes that the chemical evaluation of proteins by amino acid analysis will give a first approximation of their value in metabolism, but not in digestion, that it will aid in explaining differences in the metabolic utilization of proteins, and in attaining the most effective supplementation among different protein foods. However, biologic evaluation of proteins and protein mixtures is still the "court of last resort."

Hippocrates two thousand years ago recommended unbolted wheat meal bread for its salutary effects on the bowel. Magendie, the father of modern nutrition, fed dogs on dark, coarse bread and "high grade" white wheat flour. Dogs on the latter diet died in less than 60 days, while those on the whole grain flour ration survived for a long time.

Bread-eating populations, especially if eating bleached white flour, must depend upon "protective foods" of high quality, vitamins, and minerals (meat, eggs, dairy foods, fish, fruits, vegetables, and whole wheat). The Danish Commission on Cereal (1950) studied the effects of milling of wheat and rye on all nutrilites and concluded that there is a case for enriching flour with calcium, iron, riboflavin, and thiamin. The essential amino acid lysine of wheat may be destroyed (up to 25%) in bread baking.

Lord Boyd-Orr (1942) showed that during the Napoleonic Wars men from northern England and southern Scotland who lived in the

country and had plenty of whole wheat, meat, milk, eggs, and vegetables were big, powerful, and energetic men who made the best infantry soldiers of Europe. During the Boer War many recruits from this district were not physically fit for soldiers. A commission investigated and found most of these folk had moved to slums of industrial centers where their eating habits had changed, and that they were depending on white flour and sugar for energy. Many examples from other countries could be cited. The nutrients of wheat in bread and flour are given in Table 9.

TABLE 9

Nutrients of Wheat

Nutrients (Wheat)	White flour	Enriched white flour	Whole wheat flour
Thiamin—mg. per lb.	0.3	1.7	2.3
Riboflavin—mg. per lb.	0.15	1.2	0.6
Niacin—mg. per lb.	3.5	6.0	26.0
Pyridoxine—mg. per lb.	1.0	1.0	2.0
Pantothenic Acid	2.5	2.5	5.0
Vitamin A—mg. per lb.	nil	nil	1.5
Vitamin E	nil	nil	1.4
Fat, pct.	1.2	1.2	2.4
Protein, pct.	11.0	11.0	12.7 high quality
Calcium, pct.	0.02	0.02	0.045
Phosphorus, pct.	0.092	0.092	0.423
Iron—mg. per lb.	3.0	6.0	20.0
Manganese—gm. per 100 calories	0.1	0.1	6.7
Potassium, pct.	0.115	0.115	0.473
Copper—gm. per 750 calories	0.40	0.40	1.6
Ash, pct.	0.37	0.37	1.70

If a grain of wheat was cut up into thin slices and viewed microscopically, it would be found to consist of:

1. Germ, or embryo, comprising about one and one-half per cent of the grain.
2. The kernel, or endosperm, making up 85 per cent of the grain to be used as nutrient for the embryo. It contains gluten and starch.
3. The bran, or outer skin, composed of cellulose, making up about 13 to 14 per cent of the whole. Bran contains much mineral matter when ground into flour.

When water and yeast are added to ferment the dough, the gluten, which is viscid, holds the spongy mass until after it is baked. No other cereal has gluten; hence, breads like wheat bread cannot be made from barley, rice, corn, or oats.

Generally, the kernel texture of wheat relates to protein content, i.e., in the same group, varieties, and forms. Hard kernels contain more

protein by weight than soft kernels. The emmers contain 3.7 per cent sugar, and spelts, 2.8 per cent. The approximate composition and texture of some wheat flours are shown (Table 10).

TABLE 10

Some Wheat Flours

	Sugar	Flour texture	Milling	Flour yield	Ash	Crude protein
	pct.			*pct.*		
Naked emmer	4.3	......	......	......	0.90	11.0
Durum	3.7	Granular	Very hard	70.9	0.85	10.57
Poulard	....	Granular	Hard	69.8	0.76	7.53
Common	2.8	Soft	Soft	70.8	0.49	10.08
Polish	....	Granular	Very hard	69.7	0.94	11.03

D. A. Coleman, *et al.* (1930). Milling and baking qualities of world wheats. U. S. Dept. Agr. Bull. 197, 135-137.

Bread

A large literature has grown on the origins of bread and beer fermentation, which we can only touch upon here. The Egyptians appear to be the inventors of yeast-fermented doughs and the first bakers of leavened bread. In the Nile Valley—that "narrow teeming tube of humanity," as Dr. John Wilson has put it—the Egyptians who, according to Herodotus, "did everything in a different fashion from ordinary men," let their pounded cereals, wheat, and barley ferment, so that the dough was filled with bubbles of carbon dioxide and when baked was bread as we know it. Herodotus further observed in high good humor, "the Egyptians knead their dough with their feet, but clay and mud with their hands." They developed 50 kinds of breads and cakes, muffin-shaped, long rolls, spiced breads, and breads sprinkled with flavoring seeds like the Vienna rolls of today. Egyptians were known in antiquity as "the bread eaters."

The rising of bread referred to by Paul (I Cor. 5:6) as "little leaven leaveneth the whole lump," shows insight into the communicable nature of fermentation, but the microscope was essential to the discovery of microorganisms. The great German chemist, Justus von Liebig, according to Samuel W. Johnson, Winton and Winton (1939), remained skeptical when Louis Pasteur's evidence of yeast fermentation became accepted elsewhere. Von Liebig referred to Pasteur's yeast plants as "bugs that ate sugar, felt sick, and came down with a diarrhea of alcohol." Wittmack (1896) examined microscopically some Egyptian bread 4,500 years old and observed many yeast cells (there are about 100 million yeast cells per gram of dough, hence the important contribution of yeast to nutrition), and that bacteria of the butyric acid group were very numerous, as well as lactic acid bacteria. The starch was

largely gelatinized, but unchanged wheat starch grains were found which gave the characteristic blue reaction with iodine. Others have observed this picture in "mummy bread." The self-rising breads of antiquity and the sour dough breads of today depend upon a spontaneous mixed flora of bacteria to produce the organic acids and "bouquets" characteristic of these primitive technologies. Unpleasant ropy breads, caused by the slimes from growth of soil bacteria (*B. mesentericus* usually) in the dough, were eventually controlled by adding vinegar (3.5 pints of 100-grain vinegar per 600 pounds of flour). Red bread, which caused consternation among peoples up to recent times, is due to infection of the baked bread, polenta, or porridge with *Serratia marcescens,* a deep red chromogenic bacterium.

Sir William Crookes called wheat "the most sustaining food grain of the great Caucasian race." The Chinese regarded it as a heavenly gift, the Greeks ascribed it to Demeter, the Romans to Ceres, and the Egyptians to Isis. H. E. Jacobs (1945), in his interesting "Six Thousand Years of Bread—Its Holy and Unholy History," describes the whole land of Egypt as having the aspect of one long oven, whose function it was to supply both living and dead with bread and brew, for yeast is the midwife of both bread and beer.

The emmers were bread-wheats, but are now porridge-wheats. Wheats of the spelt group are the modern bread-wheats. Einkorn, Polish, and some durums are poor for modern breads, and einkorn is used largely for porridge and stock feed.

One of the earliest mechanical devices originated by man was the stone saddle-quern and crushing cylinder used in household grinding of wheat and barley. In Neolithic times this grinder may have replaced the older practice of munching parched grain. Some of the early Capsian industries show mortars and pestles which may have been used perhaps for grinding coloring matter (ocher, malachites, etc.), but in the Neolithic of Capsian tradition, mortars and pestles which are found more abundantly may have been used for both grain and coloring-earths. The rubbing-querns are found global in distribution. The next improvement, the pounding mills, supplanted the original upper stone and a later rotating upper stone was devised. This enabled the women to work in an upright position. Flour sieves came into use in Third Dynasty Egypt and by 2000 B.C., leavened bread and professional millers and bakers had made their appearance in Egypt. The early Romans used mortar and pestle. The circular mill or quern was produced about 350 B.C., consisting of a lower cone-shaped stone and a hollowed-out capstone. The capstone contained a center opening into which grain was poured and the upper stone was turned by asses and slaves. We have not the

space here for descriptions of early grain technology, except to note a statement of Pliny (Nat. Hist. XVIII, 20): "Bread depends upon the goodness of the wheat and fineness of the bolter. Pound the wheat grains with sand to remove the husks, the grain then being but one-half its former measure. Then 25 per cent gypsum is added to 75 per cent of this meal and mixed, and the flour is bolted. The first residue in the sieve is the coarse refuse. The sifted flour is sifted again and the finer product is called 'seconds.' The crifaria, or pure sieved flour, is passed through a sieve of most perfect fineness. In this manner are the sands eliminated."

It appears that no country colonized by the Romans ever gave up the habit of eating white bread of wheat and drinking wine. The Swedes, like their ancestors, are generally not wheat-bread eaters, but are "rye biscuit grinders." They do not usually eat Roman bread or the soft rye bread of the German-Russian folk. The English, Scots, and Irish once ate the hard rye, barley, and oats bannock.

In prehistoric times in Sweden, barley was the most important cereal, but with climatic irregularities it was an uncertain crop. Crop failures usually led to migration, but as Erlend Nordenskiold (1921) pointed out, "Peoples may flourish and in time pass away, but for any given area there will persist a culture which, within certain limits, is much the same."

Before leaving our wheat field it may be of interest to note the work of Dr. C. I. Nelson and Dr. J. M. Birkeland (1929), who extracted protein fractions of various bread-wheats and by serological (precipitin) tests, classified wheats according to their genetical composition. Where there is antigenic difference, allergies may arise from eating one wheat but not another. The nutritional effects have never been studied. Nitrogen starvation of the wheat plant was found by Professor Nelson to alter the serological specificity of a wheat globulin! The influence of soil nutrition on the nutrition of man and his animals is a phase of ethnobiology which is rapidly becoming recognized to be of some importance.

Reith *et al.* (1949) point out that varying amounts of phytic acid in wheat influence unfavorably the calcium intake in whole wheat breads, although phosphorus, thiamin, and niacin are adequate, while the riboflavin content is too low for all diets. However, A. R. Walker (1951) discounts the effects of phytic acid on calcification in humans.

Beer

The beer brewed by Egyptians, and by Sumerians in the lower Mesopotamian Valley, according to Sir Gaston Maspero and Dr. E. Huber, was first a combination job of the baker of bread. C. A. Kloss

(1950) finds that barley beer was first brewed in both cultures much after the same method which he pieced together from Huber's 23 scenes from reliefs and his descriptions of their ancient practice. The barley was moistened, allowed to germinate a little, crushed, and made into dough. After fermentation began, it was sun dried and the cake crumbled into a jar. Water was added and the liquid strained off. This method produced acid beer—called *boozah* by the modern Nilote, who follows the method of his ancestors. The Belgians also use spontaneously fermented barley beers which they call faro. Women were the brewers and bakers in ancient times. By 1000 B.C. the Egyptians had produced hops beer, but preferences in the Fertile Crescent were for bitters and spice beer. The art of brewing by fermenting the liquid "set" was passed on to the Semites, Greeks, and ultimately to Rome, but in the Mediterranean grape countries wine supplanted beer, although beer was made and used in copious quantities by the Beaker folk, Celts, Germans, and Scandinavians, upon introduction of cereal agriculture. Naturally, beer is a very nutrient food. A weak beer contains the vitamins riboflavin, niacin, pantothenic acid, and pyridoxin, as well as protein, 0.3 to 0.4 per cent, minerals, 0.1 per cent, carbohydrates three per cent, alcohol three to four per cent, and other vitamin B complex constituents of yeast, as well as barley. Calcium and phosphorus each reach about 0.014 to 0.016 per cent (about one-tenth daily requirement in one pint of beer). The B-vitamins mentioned are present in about equal amounts, or about one-fifth daily requirement in one pint. Weak beers average about 200 calories per pint, while strong beers exceed 400 calories. The effect of alcohol on Egyptians who frequented taverns thousands of years ago is best left to the descriptions in Sir Gaston Maspero's "Everyday Life of the Ancient Egyptian." The German word *Gemütlichkeit* summarizes the best features of beer without cluttering up psychology and narcosis.

The best opinions are that the Egyptians made barley beer and started the flowing bowl on its career, which has played so vast a role in the history of the world. The Yassa, Genghis Khan's code of laws, regarded drink in a practical light: "A man who is drunk is like one struck on the head. His wisdom and skill availeth him not. Get drunk only three times a month or do not get drunk at all. But who amongst warriors can abstain altogether?"

Barley (Hordeum)

Barley was called *djot* by the Egyptians, and *djavas* by the Aryans of India. Barley and wheat, as we have seen, often occur together in the same Neolithic field, but barley has always taken second place to wheat. The Jews, in antiquity, however, continued to use barley as a secondary

food for a long time, although in the Book of Judges an Israelite dreams of barley bread falling into a camp of Midianites and destroying them!

When bread was invented in Egypt, the use of barley fell off because it does not bake well. Wherever unleavened cakes and porridges were the chief, culinary forms of cereals, barley persisted. We saw mixed barley and wheat at the Fayum K site of Neolithic times where the evidence there, but better elsewhere, shows flat grain cakes were roasted. Sometimes wheat and other cereals were pounded and crushed in a mortar and then soaked into a pulp and dried as a cake in the sun. Virgil (Georgics i, 267) refers to this practice. The process of parching, toasting, popping, or puffing cereal grains is very old in the Neolithic. Swiss lake dwellings in the Neolithic of that region show that six-rowed barley prevailed, in Egypt four-rowed, and in Greece two-rowed. *Hordeum vulgare* was widely distributed in North Africa, predynastic Egypt, and India. In Anau, *H. distichum* was found and is still a wild form in western Asia, as is *H. spontaneum*. The two-rowed barleys were used for malting. The four general groups of barley used in pre-history were

H. vulgare
H. distichum
H. intermedium
H. deficiens

Barleys grow where wheat does not, in the North or on poor soils, and are used for soup, beer, animal feed, barley water beverage, malt extract, porridge, and flat cakes. Barley is often the marginal land (desert's edge and Arctic edge) cereal—one of the hardiest of the important cereals since it also requires only a short season for growth; but buckwheat is the "billy goat" of the cereals, tough and subsisting on rough, adverse lands. Buckwheat contains 150 μg. of riboflavin per 100 gm., 280 μg. of niacin, and 600 μg. of thiamin. Barley contains little or no gluten, like wheat possesses, but a nonporous bread can be made from it. In the Egyptian Book of The Dead, Osiris is represented saying, "I am barley," suggesting the Eucharist.

Oats (Avena)

Dr. Vavilov (1951) shows oats to be a weed in the northward movement of emmer, and oats finally grew in pure culture in northern lands. Wild oats seem to be a native of Eastern Europe and Turkestan, but are found over a wide area from Iran to Africa. It had been a weed in wheat fields of antiquity. Oats were grown in Bronze Age lake dwellings of Switzerland before 1000 B.C. *Avena sativa* was derived from *A. fatua*,

or wild oats. In China was found *A. nuda,* and in places in the Mediterranean basin there are growths of *A. sterilis.* Oats as a human food was discarded in predynastic Mesopotamian times and all through classic times it was held in low repute as a human food. The Scythians who ate this "cattle feed" were decried by the Greeks, as were the Gothonics by the Romans, and the Scots by Johnson. Some physicians in old Rome recognized the great nutritional value of oats, although St. Jerome says, "only brutes are fed oats." Today, properly prepared oats are regarded as one of the most nutritious of all cereals! Mottram and Graham (1940).

Rye (Secale)

Oats and rye can be grown beyond the limits of wheat, under colder and damper conditions. Both were weeds of wheat cultivation. Rye is still a "weed" in greater parts of Hither-Asia. Theophrastus believed that wheat grown on poor soils would turn to rye! Botanically this plant is so closely allied to wheat that it is difficult for the novice to distinguish them in fields. A few botanists believe that rye came to Europe by way of South Russia in early times, as a mimic contaminant of Pontos (Black Sea) wheat. Rye makes excellent bread, as does wheat, although risen bread is not readily prepared from oats, millet, corn, or barley. Ryes are classified as *Secale cereale.* Cultivated rye is derived from *S. montanum. S. fragile* is found in Hungary and on the eastern sandy plains. Rye was grown in Europe during the Hallstatt Iron Age, but not plentifully until Roman times in Central Europe.

There is no rye in the Swiss lake-sites nor is there a name for rye in Chinese, Sanskrit, Semitic languages, or Egyptian. Rye has long been a chief cereal in northern and western Europe, where ergotism prevailed for centuries. In the overlong reign of Louis 14th, the peasants of Franche-Comté eked out their rye by mixing clay in it before baking bread, Renard (1929). The reward of good cereal farming is, however, greater than any other form of agriculture. Gathering and threshing grains was less laborious than digging roots. Cereals are easily stored, so that surpluses can be accumulated against crop failure.

Other Cereals

The millets are a group of grasses of different genera, as are sorghums. These tall grasses can be cultivated under conditions adverse to wheat, barley, or rice. They withstand drought or great humidity during their growing season. True millet, *Panicum miliaceum,* was first cultivated in the wheat-barley zones, Swiss lacustrine sites, and in

Rome the common species was *P. italica.* In early China it was one of the six royal cereals. "Father Millet," "Foxtails," or wild millets like *Setaria italica,* were grown in China in very early times, as well as giant millet, or kaoliang, with its cornlike leaves and heavy heads of red-brown grain. Millet porridge was widely used for breakfast in Europe until tea and coffee came in. Many occidental people now dislike the flavor of millet. Millet *(P. miliaceum)* contains 740 μg. of thiamin per 100 gm.; protein 11.56 per cent; water 9.4 per cent; fat 3.29 per cent; and fiber 10 per cent. Corkhill (1940), in his study of Sudanese millet eaters, found millet deficient in protein, thiamin, riboflavin, niacin, and vitamins A and C, when the cereal was eaten solely during the dry season. A multiple deficiency syndrome was rife among the Sudanese under these conditions.

Eleusine, *E. coracana,* resembles *Panicum* closely and was widely distributed from Abyssinia to Japan. Seeding of the Nile Valley and delta, as well as the Persian delta, by wild cereals brought down in flood from their respective highland sources, is thought by some to be a factor of dissemination in prehistoric times.

Sorghum, *Holcus sorghum,* or Kaffir corn, grows best under tropical conditions both in forest clearings and drier grasslands. Excavations of deposits of Minoan (Mycenean) time, yielded millet and mustard seed (thought to be a preservative) charred together, in an animal skin which apparently had been a leather bag containing the seeds. *Paspalum scrobiculatum,* or varagu, is a millet used by the poor of India as staple food. When rice is scarce, more varagu is consumed, resulting in a food poisoning in many parts of the Madras Presidency. The toxic principle is in the fat fraction. *Elymus arenarius,* sea lyme grass, was used in Iceland for its grain, and timothy, *Phleum,* was used in Europe and northern Asia in two species, *P. pratense* and *P. alpinum,* but usually as a fodder.

Rice

Cultivated rice, *Oryza sativa,* falls into two environmental groups, swampy and the poorer "hill culture." Wild species similar to cultivated rice were found in South Asia and tropical Africa, but over 1,000 varieties are now found in India alone. *O. sativa* is supposed to have originated both in China (2800 B.C.) and India or the lands to the east of India. Rice feeds a larger proportion of the world's population than any other food. It is eaten in a great number of culinary dishes and fermented into arak and sake. A wild rice, *Zizania palustris,* called Indian rice, was used by the aborigines of North America.

Rice is the chief food and source of energy for about half the people in the world, most of them living in the Oriental countries, where some 95 per cent of the world's rice is produced and consumed. Rice is a cheap and abundant crop, easy to grow on little land, and well adapted to the climatic conditions of the East Indies and the Asian coast from India to Japan. Natural or brown rice spoils rapidly and cannot, under ordinary conditions, be stored safely until the next harvest.

In much of this area, there is chronic undernourishment, malnutrition, low vitality, impairment of general health and physical development, and a high incidence of diseases resulting from insufficient and improper diet. Ranking high among these diseases as a fetter and a killer of mankind is beriberi. It results in numbness of the hands and feet, muscular weakness, painful lameness of limbs, a general ill-health, wasting away or dropsical swelling of the extremities, and, in the end, death from heart failure. Infant deaths are usually two-thirds of the total beriberi mortality; in babies feeding at the breasts of ill-fed mothers, the disease often runs its fatal course within three days.

The rice grown by these people has many of the vitamins and minerals they need, but by the time it is milled and polished, then washed and cooked, it has lost almost all of them. The taste of cooked white rice appeals to their palates; the bulk appeases their hunger; the protein, carbohydrate, and calorie contents give them the strength to live and work; but the grain, robbed of many of its health-giving elements and reinforced with little other food, also invites disease and death.

In its natural state, rice has good nutritional values, comparing favorably with those of the other major cereals used as food staples around the world. It is better than corn and approximately as good as wheat. Brown rice—rice freed only of its chafflike hulls—has about the same calorie content, vitamins, and minerals as whole wheat; somewhat less protein; more fat and carbohydrate.

There are some areas, however, where the rice most in demand and most acceptable is not white. These regions, mainly in India, traditionally prefer parboiled rice—rough rice steeped in water and dried in the sun to loosen the hulls before milling. While this practice probably originated in man's attempts to lessen the labor of hulling, it has had far-reaching health benefits, for it drives some of the vitamins and minerals from the bran into the kernel. Where it is eaten beriberi rates are low.

But parboiled rice has a slightly different color, taste, and odor; these characteristics have discouraged its use by those unaccustomed to it. Thiamin, riboflavin, niacin, and iron are retained in all improved forms of rice, even with the worst cooking practices, and the early rice eaters

of food-producing times did not suffer deficiencies and their aftermath. Enrichment will solve the problem for Oriental folk.

The Sabbatical Year

We may note at this point the Sabbatical Year, E. D. Owen (1938), a direct heritage from the Hebrew institution of the seventh year of fallow for fields, and indirectly an older regulation. Economic logic supports the antiquity of the practice. The curtailing of grain production on the seventh year led to culling of unfit livestock for food and lack of animal feed, and increased the tendency to trade with neighboring countries. The fallow year helped the land, provided the tribes did not move on to richer clearings or prairies.

CHAPTER VIII

Foods of Orchards and Gardens

Fruits, Vegetables

Orchards and vineyards discouraged nomadism for many peoples in the great Fertile Crescent in early food-producing times. Most plants of direct importance to mankind of the Old and New Worlds were discovered by prehistoric men and women. In the Near East and India dates, olives, figs, pears, apricots, grapes, peaches, sesame, onions, garlic, lettuce, melons, beans, peas, cherries, apples, nuts of various kinds, mulberries, egg-plant, mint, cardamons, pennyroyal, dill, saffron, coriander, thyme, mangold, turnips, radishes, cucumbers, and lucerne were utilized before the Bronze Age began, as supplements to foods of animal origin and grains of the hoe-culture fields. Orchard husbandry and hoe culture and later ox-plows, lightened the labor of women who had formerly delved with their dibble-sticks and hoes. Field cultivation began and may have developed from gardening in Mesopotamia before 3000 B.C., in China by 1300 B.C., in Sweden before 1300 B.C., and in England by 800 B.C. Singularly enough, *paradise* means garden.

Chevalier (1947) believed that certain wild fruit trees were dispersed by man before the invention of agriculture. Man's first means of living was not altogether by hunting but by subsisting upon sprouts, nuts, roots, and fruits. Plants may have played an essential role in the nourishment of pre-Paleolithic hominids and some Paleolithic men. Climatic changes during the last glacial, and desiccation of certain tropical lands caused men to emigrate and to expand the dispersion of food-bearing trees. Using fire, they created open places —a possible origin of "climatic" Eurasiatic forests where only one species dominates, i.e., acorn-oak, beeches, hazels, and certain conifers and apples.

In Sweden, Dahl (1945) found large amounts of dried and charred apples in the hearths of Neolithic palafittes at Alvastra (Östergötland). He dried some common varieties of apples now growing in Sweden and compared them with the Stone Age apples. The apples of Neolithic times must have been considerably larger than the wild apples now to be found there. It appears that some kind of fruit growing was already practiced at this early epoch. The Alvastra apples belong to *Malus silvestris,* rather than to *M. pumila* (domestica). Stones of cherries now growing abundantly in the neighborhood were not found, but many large hazelnuts were the same. Hazelnuts were an important food in the

North in Mesolithic times. Some students of Norman history observed that the ancient and modern apple orchards of Normandy were brought thither by the Vikings, although these famous orchards were generally thought to date from pre-Norman times. The apples of the Swiss Lake villages and the Swedish Neolithic of Alvastra show both large and small varieties which indicate some sort of cultivation or protection of trees. No great advance in growing fruit orchards was made in temperate Europe until the Middle Ages. A Greek of classical antiquity complained that some apples were "sour enough to turn the blade of a knife."

Upon observing that overripe fruit dried on the trees and remained edible, protoliterate folk may have developed sun drying of fruit.

Cherry trees are thought to have been introduced into Europe from Cerasos on the Black Sea, by some of the many migrating folk of food-producing times. The peach, *persica*, is of Persian (Iranian) origin and the Asiatic origin of the fig, quince, pomegranate, and lime appears not to be disputed. De Candolle long ago taught that Asia was the original great provider of all important plant foods until post-Columbian times. The first orchards are believed by Vavilov (1951) to have been planted in Hither-Asia during the late Neolithic of that region, where to this day one may see all phases of evolution in fruit growing, from wild fruit trees, transitional orchards, and finally grafting of desirable wild varieties.

Aside from heavy frost, many species of trees will survive heavy sleet storms without damage. Flaig's (1947) studies point out that fruit trees suffer most from sleet, evergreens are not damaged, and minor injuries to oaks, walnuts, horse chestnuts, and hickory are the rule. A typical example of a climate inimical to trees is that of Iceland's, whose mean temperature is approximately that of Chicago's. Cold periods and growing days may suddenly alternate, to the destruction of saplings and trees. The Atlantic areas of northern Scotland and Orkneys were at times heavily forested during the Mesolithic and later times, as large tree roots bear testimony.

The wild grape, *Vitis sylvestris*, was found in Germany in Neolithic and Bronze Age times, C. Bertsch (1939), and was of wider distribution in Europe in post-glacial times than at present. Kryshtofovich (1938) in his paleontological history of the grapevine, found evidence to show *Vitis vinifera* originated in the Mediterranean regions, but fossil specimens had been reported from Wetterau, Germany, supposedly dating from the Pliocene.

The common varieties of nuts are usually rich in fat (40 to 60 per cent) and protein (9 to 25 per cent), with niacin ranging from 1.2 to

16.2 mg. per 100 gm. Common berries like cranberry, raspberry, and blackberry contain 10 to 15 per cent carbohydrates and little niacin, little protein, but if fresh, much ascorbic acid, or vitamin C. Alfalfa (over 50 species) and the true clovers (*Trifolium,* over 230 species) are found in early Persia and Asia Minor. Lemons, oranges, and apricots are believed to have been cultivated first in India and the East. The olive tree may be indigenous to Asia Minor and Greece.

A Bronze Age settlement in the Grotta Misa of the lower valley of the Fiora river in Italy was studied by Tongiorgi (1947), who found the plant life to be fruits of many kinds, numerous species of forest trees, wheats, millets, broad beans, and grapes. The beeches are no longer found there, but environmental conditions were thought to be similar to those of modern times. Gathering of wild, edible plants still continued in Europe long after the Neolithic. For instance, Lechler (1945) lists 193 species of plants from a Neolithic site in Germany, 29 of which were more or less domesticated, 17 of which were used until recently. Creation of meadow and cultivated land increased the range of wild plants for gathering. Chancy harvests of cereals determined the supplementary uses of these wild plants. The European forest tracts were especially rich in chestnuts, beechnuts, acorns, hazelnuts, plums, haws, elderberries, strawberries, blackberries, and raspberries.

According to Biblical tradition, the half-starved Hebrews in their flight from Egypt recalled the flesh-pots and bread of Egypt, but hankered more for "the garlic, onions, leeks, melons, and cucumbers." Melons may first have been developed by man in the Kiva oasis and in Asia Minor.

It was discovered early that olives when fully ripe, which is soon after they become colored but not black, contain the maximum amount of oil. When green, the olive yields a bitter oil, and when too ripe, the oil is rancid. The flesh of the olive is about one-half oil and was crushed between heavy stones, the pulp made into cakes in cloth, and then pressed. It proved to be an excellent energy food and very digestible. The olive also is a rich source of calcium. The sesame plant and date palm provided oil for the Babylonian world. The folk of the Ancient World said that a long and pleasant life depended upon two fluids: "wine within and oil without."

Spices

The majority of spices and aromatic plants was believed by De Candolle also to be of Asiatic origin. "Spice is the variety of life" say the modern students of spices, who unanimously believe that all the

flavoring or condiment plants were discovered accidentally by prehistoric folk. Surely food acceptance has been profoundly influenced by spices! Some hunter in pre-history roasted his meat over a fire of cassia wood, or a few peppercorns dropped accidentally into a boiling pot of a Neolithic village cook, and the flavors were desired. At first each spice was used by the isolates, but the transition from tribe to empire pooled ethnobiological customs, resulting in the spice trade, which has ever grown. The spice trade was extensive in the dawn of history and may have been an incentive to establish caravan and sea routes. The diffusion potential must have been great. Adventure tales of spice traders grew into well-recognized classics like "Arabian Nights," which gave the trade glamour and romance. As recent a writer as Pliny describes the gigantic trade in spices and silks from China and India which exceeded Roman exports by five million dollars—a huge sum in his day, as it should be in our times. "So dearly do we pay for our luxuries and our women," he adds.

The spice trade united the Orient and Occident with well-established trade routes in ancient times, and the Roman was probably more familiar with Oriental products than medieval man, down to the time of the Polo family. Asia has rarely sent its wares to Europe; Europe has usually gone to get them. Incense, spices, and salt—three classes of substances usually associated with microbial action — were some of the chief economic necessities of the ancient world. Spices were often used in the days before adequate refrigeration, perhaps to mask taints in foods. The acquired tastes for spices are more evident in warm or tropical regions—just the latitudes where taints and putrefaction take place in the shortest time, in perishable, unprotected foods. When taints were masked, it was assumed that destructive processes were stopped. The importance of spices and the trade routes to India to obtain them, had some influence on Columbus, who, historians tell us, set out to find a new and shorter route to the Orient in quest of spices.

Mustard, *Sinapis*, was used early as a flavoring and the old Egyptians, Minoans, and Romans used mustard as a preservative and medicine. In the Bible mustard is called a small but powerful seed. It was introduced into Britain by the Romans and used to preserve *must* or grape juice, hence the etymology—mustseed, corrupted to "mustard" in Anglo-Danish times. Viticulture was practiced in Roman England to a larger extent than in more recent times.

Pepper was one of the first spices to be used by Europeans. Alaric, King of the Visigoths, demanded as a part of the ransom of Rome (410 A.D.) 3,000 pounds of whole black pepper, as the craving for

spices was great in his army. Strong commercial interests were always apparent in the spice trade in ancient and medieval times. In 11th and 12th Century Europe, there were official "Pepperers," whose duty it was to see that spices which were very costly were not adulterated. Hand-carved wooden "nutmegs" were often found mingled with imported genuine nutmegs.

In England of 1440 there were over 50 plants suitable for cultivation. Most of them were savory herbs grown for flavoring meat, which was usually tainted in summer, or for salted meats in winter, when these foods were slightly tainted or had lost their flavor. Chaucer wrote of his Sompnour: "Wel loved he garlike, onions and lekes." Onions were so popular that they were imported from Flanders. Saffron was grown in East Anglia and was high-priced. Piers Plowman says of spices:

"Has thou ought in this purse?
quod he
Any hot spices?

I have peper and peony.
quod she.
And a pound of garleek
and a ferthyng-worth of fenel-seed
for Fastynge days."

In England the Pepperers of the 14th Century were in charge of the "great beam" scales, or *peso grosso* weights. The pound equated 15 ounces. They became known as *Grossarii* (from whence grocer) and they had charge of "garbelling" the spices (Ital. *garbellare:* to sift), meaning to sift and inspect. The grocers were given fees for garbelling and were empowered to confiscate adulterated or bad quality spices and condiments.

A curious remark from the Bulletin of the National Association of Purchasing Agents (U. S. A.) (1950) shows the "racial memories" associated with spices: "Pepper was rated as a strategic war material in World War II, when coffee and some other far more necessary imported materials were not, giving the impression that planners were planning in terms of long-forgotten wars."

Cinnamon, or cassia, was used as incense and spice in early China (1700 B.C.) and in Egypt (1700 B.C.). It is of Far-Eastern origin and obtained from evergreen trees, the bark of which is stripped. Cassia as we now know it is strong, while cinnamon is mild and delicate in flavor. There are many varieties.

Cloves were first utilized in early China and Persia to sweeten breath when talking to royalty, and it is recorded that cloves were effective in love potions and douches. Coriander is mentioned in the Ebers papyrus (1500 B.C.) and Sanskrit literature, and the Bible mentions its use as medicine and spice for meat. Cardamon is a perennial plant of the ginger family with small yields (hence costly). It was used early and imported from southern India. Caraway seed is mentioned in the Ebers papyrus, but is a biennial plant native to Hither-Asia and now north and central Europe. Basil now grows in western Europe and is used in spaghetti sauces, but the early Hindus used it as a decorative temple and household plant.

Paprika, chilies, and cayennes all belong to the genus *Capsicum*, and are found in early Eurasia. Many important species were grown in pre-Columbian Central America.

Dill is an annual herb native to India and the Fertile Crescent, as is ginger. Turmeric was the most precious spice of the caravans out of the East and was used by the Sumerians, Chinese, and East Indians. Fennel seed (Ital. *finnochio*) is a sausage spice and was used in Greek and Roman times. It is of Mediterranean origin. Anise seed is the oldest spice or herb recorded as a medicine for coughs and flavoring for numerous foods. Allspice is native to Jamaica. Three antiseptic spices shown by bacteriologists to have a little preservative value are allspice, cinnamon, and cloves. Many spices tend to retard rancidity in fatty foods when added in a dry, powdered state.

Centers of Origins of Cultivated Plants

Vavilov (1934, 1951) defined the science of plant and animal breeding as "evolution directed by the will of man." He recognized eight independent world centers of origin of the most important cultivated plants: (1) Chinese center (a few examples are millets, buckwheats, soybean, radishes, rhubarb, cabbages, Spanish onion, an eggplant, large cucumber, apricot. (2) Indian, exclusive of Punjab and northwest India (rice, certain peas and beans, yam, orange, tangerine, citron, sugar cane, sesame, hemp, black pepper). (3) Indo-Malayan (bamboos, yams, ginger, banana, breadfruit, cocoanut palm, sugar cane, many spices). (4) Central Asia including Punjab and northwest India (vulgare, club and shot wheats, lentil, peas, mustard, sesame, spices, turnip, a radish, onions, garlic, spinach, pears, English walnut, certain apples, apricots, cherries, and almonds). (5) Near East (einkorn, durum, poulard, Persian and vulgare wheats, two-rowed barleys, rye, oats, lentils, peas, alfalfa, a sesame, flax, spices, cantaloupes, a cucumber, some pumpkins

and melons, carrots, many varieties of cabbages, onions and leeks, lettuce, fig, pomegranate, some varieties of apples and pears, quince, grapes of great diversity. (6) Mediterranean (emmer, durum, Polish, spelt wheats, cloves, spices, olive, beets, cabbage in great variety, turnips, parsley, chives, celery, chicory, parsnip). (7) Abyssinian (numerous wheats and barleys, sesame, lentils, millets, coffee, spices, okra). (8) American; Central and South (Peru, Chiloe Island, Brazil): corn, beans of many kinds, sweet potato, spices, upland cotton, papaya, avocado, guava, cashews, tomato, cacao, anatto, numerous varieties of potatoes, squash and pumpkins, quinine, tobacco, strawberries, manioc, peanuts, rubber trees, varieties of cherries, pineapple, and Brazil nuts.

Until primary and secondary centers of origin are better known, some students may question the coincidences of various genera and species because of the problem of diffusion in pre-history and early historic times.

CHAPTER IX

Domesticated Animals and Protein Foods

Domestication of Animals

There is not an animal in the barnyard or on the range today with which Neolithic man was not acquainted and had tamed some place on the earth. There is controversy over the motives for domestication and livestock raising, but the food motive, which yielded the all-important sources of flesh, milk, and milk products, was recognized in early history. Adoption of young animals for pets, as P. C. Mitchell (1913) has shown in his study of childhood of animals, could well be the method of domestication. The process of domestication requires breeding a race of animals in captivity for many generations, and gradually weeding out those in which youthful tameness is replaced by the wild instincts in adult life, and so creating a strain with new and abnormal instincts, Mitchell (1913). Men and animals coming to the same watering places during the desiccations of the Iranian plateau and of the Fertile Crescent were brought in contact, where the idea may have caught on. The teleological or accidental features account for just the suitable native beasts which could be domesticated. The wild ancestors of many farm animals were not in cold Europe but in well-watered Hither-Asia, Asia, and the lands of the western Crescent.

H. and H. A. Frankfort, John A. Wilson, and Thorkild Jacobsen (1949) in their essay "Before Philosophy," showed how early historical man in the Near East viewed Nature. He did not think with the discipline we now associate with reasoning. The realm of Man and the the realm of Nature were not distinguished from each other. For us the correlation "subject-object" is the basis for scientific thinking, but another mode of cognition is the curious direct knowledge, when, for instance, we understand a creature confronting us in its moods, anger, or fear. This form of knowledge we share with the animals. Transitional Neolithic man was better fitted to understand and domesticate animals than his successors for many centuries to come.

Of the primates, apes and monkeys have never been domesticated, and Man has ever chafed at the bit; of the carnivores, only the cat and dog; and of the ungulates, cattle, sheep, goats, camels, reindeer, asses, pigs, and horses. The gazelles, after many trials, were never domesticated by the Neolithic North Africans and predynastic Egyptians. Among the rodents, hares, rabbits, and guinea pigs (of South America)

succumbed to Man's will. The birds: hens from India, pigeons, peacocks, guinea hens, swans, geese, ducks, and turkeys (in Central America) early came into domestication.

The real quality of tameness is that the tame animal is not merely tolerant of the presence of man, has not merely learned to associate him with food, but takes some kind of pleasure in his company and shows some kind of affection. Tameness is more than just coming to be fed, for many animals are least tame when feeding, P. S. Mitchell (1913). (Bees and silkworms must not be forgotten in respect to their services for man.)

Food taboos of ancient origin and still found full-blown, must have exerted powerful influences then as now on selection of food animals and their products. Southeastern Asia uses little or no butter, cream, cheese, or milk; the pig was abhorrent to many Semitic folk, Egyptians, and much later, Mohammedans. Religions, not "racial appetites," may influence the major food patterns with all of the attendant nutritional deficiencies or benefits. A double custom arose of eating flesh of domestic animals offered to the divinities. Sports, pets, and ostentations of wealth also tincture the pictures.

Cattle, sheep, horses, goats, camels, and swine were all used as units of wealth in early times. The first silver coins known to mankind are said to have been based on sheep values. Some of the gold coins were based on cattle values, hence *chattel* = cattle; *pecunia* = pecus, cattle. There are not a few philologists who derive the Phoenician alphabet of 22 signs from nonpictorial cattle brands and ownership marks. This alphabet may be the parent of Greek, Roman, modern European, Hebrew, Arabic, and Indic scripts.

Cattle

Cattle are the most important domestic animals in the history of civilization, Forde (1949). The wild ox urus *(Bos primigenius)* was widely distributed in southwest Asia in the late glacial period, and in eastern Europe survived until recent times. The Pleistocene aurochs *(Bos taurus primigenius)*, ancestor of European domesticated ox, became widely distributed in the Northern Hemisphere and was common in early Europe and the Fertile Crescent. After the European forests were destroyed by man in medieval times (before 1200 A.D.), the aurochs was hunted out of existence. However, this "living fossil" lingered on in remote woodlands and baronial forests until 1500 A.D., and in two instances until 1627 in the Jaktozorka Forest in Poland. Orientologists have stated that the aurochs was extinct in pre-Kassite

times in the Tigris-Euphrates Valley. The bulls crossed with domestic cows, which the modern buffalo never did under natural conditions. The calves from these crossings were dark-brown and the adults were black with a light stripe down the back. The aurochs' horn-span was 50 to 60 inches. These cattle were often forest animals and browsed in clearings, returning to the thickets to chew their cuds. About 100 head of European bison, which were later referred to as aurochs, may still survive at Bialowicz, Poland.

Early man followed herds of mammoth, horse, and later cattle, like our Plains Indians followed buffalo for their living. Wild cattle were hunted by Capsians of the western Mediterranean basin. In early dynastic times in Egypt both shorthorns and polled cattle were raised, as well as the longhorned *Bos taurus (aegypticus)*. The Sumerian cattle antedated Egyptian herds where cattle were grain-fed. Polled cattle are found in Egypt of 2150 B.C., although fossilized remains of all primitive breeds were horned except in Pleistocene India, where hornless breeds arose as mutants. The history of cattle in general follows the later history of man. Herodotus (History, Book IV) described polled cattle in Scythia. In Sweden a small red breed and a white breed arose from mutations and were carried by unknown peoples to Ireland and Great Britain. The primitive black cattle of the Celts gave rise to the polled Aberdeen Angus and Galloway, while the Vikings in their settlements in East Anglia developed the red polled cattle. British colonization and exportation spread their breeds of livestock over the globe. The British breeds of cattle were and are bought at good prices for shipment to North and South America, from where their descendants return in cans.

One should not underestimate the importance of shepherd dogs in the domestication of livestock. Professor T. M. Olson (1938) has called attention to the invention of gunpowder as a boon to the advancement of domestication of livestock, because predatory carnivores as well as game animals were killed off in Europe, which made necessary larger amounts of domestic animals for meat. "Villainous saltpetre" thus can be credited with additional virtues.

Hescheler and Rueger (1942), who uncovered the remains of domestic animals from the earliest lake dwellings of Egolzwil and Baldegg in Canton Lucerne, Switzerland, observed aurochs and two forms of domesticated cattle. On prehistoric sites of Hallstatt salt mines, Morton (1941) dug up horns of *Bos brachyceros*, human excrements, and totally preserved beans *(Vicia faba)*. These Austrian salt miners of 2000 B.C. herded their cattle on the meadows of the Hallstatt valley.

A typical classification of cattle subscribed to in part by many zoologists may be listed as follows:

Bos primigenius	*Bos longifrons*	*Bos frontonus*	*Bos brachycephalus*
Called Urus in Classic Antiquity	Stone Age in British Mountains and Channel Islands	Sweden Switzerland	Brittany
Holstein Dutch belted Durham Red polled Galloway Angus Ayrshire	Brown Swiss Jersey Guernsey	Swedish Simmenthal	Hereford Devon Kerry French-Canadian

All domesticated cattle belong to the taurine subgenera. The humped cattle of India are classified as Bibovine, the Leptobovines are extinct, the bison and yak are Bisontines, and the true buffalo of Asia are Budalines.

It is interesting to note that cattalo, or hybrids of western American buffalo and domestic cattle, developed in Alberta by the Canadian Department of Agriculture, are excellent range cattle but wild and fierce at close quarters, as are our Brahman-American crosses. Cattalo show very definite buffalo characteristics.

The degeneration of third-generation European cattle in the tropics of Africa, studied by Bettini (1944), shows that pastured cattle are most susceptible to direct influences of sunshine and heat, although relatively poor pastures have their effect. Many advances have been made in experimental breeding of dairy cattle for hot climates, R. W. Phillips (1948), J. P. Maule (1952), and new vistas of great importance in nutrition have opened for these countries. J. D. Findlay (1950) has reviewed for the student the effects of temperature, humidity, air movement, and solar radiation on the behavior and physiology of cattle and other farm animals. Of all the nutrients livestock derive from forages, the mineral elements depend most directly on the soil and climate. Cows need phosphorous or they starve in the midst of plenty. If there is a deficiency of cobalt they develop a wasting disease like the "salt sickness" of Florida or "Lake Shore disease" in Michigan. Lack of iodine obviously leads to "big neck" and lack of copper causes chronic diarrhea or "falling disease."

Selenium and molybdenum of alkali soils exert their influences in cattle as "alkali disease" or "blind staggers." The rapidly growing knowledge of nutrition of plants, and the profound influences on animals which eat them, cannot be covered here because facts and fancies tend

to become inseparable from labors of enthusiastic pioneers. Claims are made that brucellosis of cattle and man can be avoided if manganese and other minerals are added to soils from which cattle and man derive their sustenance!

Diseases of livestock of prehistorical and early historical times are a phase of Paleopathology which will undoubtedly receive more attention in the future. Suffice it to say here that most of the infectious diseases of animals are of venerable origin. Brucellosis in American bison was detected by Dr. T. T. Chaddock, who contracted the disease while studying pristine range herds of the Northwestern Rocky Mountains. Whether the disease led to extinction of Taylor's bison of the Pleistocene is obviously not known. Brucellosis is one of the common causes of abortion in cattle and swine and wherever this disease occurs in animals reproduction is decreased. Its effects on mammals of Paleolithic and Neolithic times conceivably could have been important. In man, however, abortion from this disease is not commonly seen. During literate time the disease has been known as Malta fever, Mediterranean fever, or Syrian fever; later as undulant fever, and finally as brucellosis. In cattle it is known as Bang's disease, and in swine as Traum's disease. It was observed in goats of the Iranian highlands and Fertile Crescent, and may have spread northward during the numerous migrations which we have described. Some bacteriologists believe that Spanish cattle introduced the entity to the New World. However, Dr. Morales-Otero (1925, 1950), an authority in his field, believes from his extensive studies that brucellosis was unknown in Puerto Rico until 1923, when infected cattle from the U. S. A. produced severe infection of native cattle, which spread rapidly. Thus far all brucellosis of man and animal in Puerto Rico is of bovine origin. Hippocrates (450 B.C.) described brucellosis in man, and Katz (1941) and Rush (1932), as well as African veterinarians, found the disease in elk, bison, moose, foxes, rats, dogs, and numerous kinds of African mammals.

Dr. W. H. Holmes (1944) cites evidence of tuberculosis of cattle and man beyond the Mesolithic, and believes that strenuous life does not increase resistance to disease but rather predisposes man and animals. The afflicted Paleolithic hunter was soon dead. Tuberculosis was more prevalent in community life, as was anthrax and other diseases transmissible from animals to man.

Milk

We have noticed the well-develped dairy industry of the Sumerians over 5,000 years ago, but we cannot vouch for a tale about the foolhardy Sumerian milkers who sat behind the cows to milk them, and observed

that: "If the gods wanted man to have clean milk, they would have placed the udder on the forepart of the cow!"

Animals which could be milked successfully were cows, goats, mares, asses, reindeers, camels, zebras (and llamas in South America). Fostering of the dairy was undoubtedly one of the important factors in keeping man on the path to civilization, and as some dairy historians state, the greatest factor in the history of development of man from a state of barbarism to the present. Dr. E. V. McCollum, a great American nutritionist, never shrank from superlatives in tracing the importance of the dairy sustenance pattern on man's welfare. In a lecture he said: "The people who have achieved, who have become large, strong; vigorous people who have reduced their infant mortality, who have the best trades in the world, who have an appreciation of art, literature, and music, who are progressive in science and in every activity of the human intellect are the people who have used liberal amounts of milk and its products."

The Egyptians, Greeks, and Romans did not often drink milk but made cheese of it. Early peoples of Persia also used camel's milk; Africans, buffalo milk; Europeans, cow, ewe, goat, and ass milk; Tartars and Mongols, mare's milk; Tundra folk, reindeer milk; Pamirs and Tibetans, yak and mare's milk; and Peruvians, llama and vicuna milk. Some primal folk regarded animal milk as dangerous to infants, fearing transmittal of traits from pap. The earliest Romans attributed the wolflike qualities of the feral Romulus and Remus to their suckling of the she-wolf.

Late food taboos have their effects, although the early Hindus in their Vedic hymns praise the milch-cow as a great benefactor, it being a sin to kill her. They made butter and drank milk. The Scythians and Asiatic nomads had cows even down to Marco Polo's time. Butter was confined to the cold latitudes and altitudes where milk was preserved until cream could rise spontaneously in one to two days, since in curdled milk gravity creaming is not readily obtainable. The ancient Athenian was a man of moderate diet, largely vegetarian, and since refrigeration or ice was not available, butter was a rare food for him. Caesar mentions the Netherlands area as a producer of cheese.

An *Ordonnance* of the Provost of Paris, November 25, 1396, forbade the coloring of butter with "saucy flowers," herbs, or drugs, and old butter was not to be mixed with new, under penalty. Butter was not to be sold in fish-stalls nor could spicers, chandlers, apothecaries, and those carrying on "offensive" trades legally sell butter. Butter was highly esteemed and we have only to recall the beautiful Tour de Beurre in Norman Rouen, built from money paid for permission to use butter in

Lent. Butterfat in various forms has been used for food and medicine since early times. Vikings and their descendants carried on overseas trade in butter, and Palgrave tells of an 11th Century Danish Viking in London talking over the current prices of butter, or "cow-smer."

Some authorities inferred that butter making in north and central Europe was introduced from Denmark. The Scotch islanders, Norsemen, Finns, Scots, and Irish often buried firkins of butter in bogs, to ripen it for flavors desired by them in those days. In Butler's Hudebras occurs:

"Butter to eat with their hog
Was buried seven years in a bog."

A few of these firkins have been found in bogs the past few years and some of the specimens are of great antiquity (11th to 14th Centuries). Some have been found in Tyrone, others in Skye, Galloway, Iceland, and Finland. The butter was very rancid and inedible. There is a curious literature on bog butter. It is remarkable that butter was eaten in large amounts in medieval England only by the working classes. The nobility and the wealthy seldom ate green vegetables and butter, but a little butter was used in their cooking. The northern countries and the Danish part of England (East Anglia and Yorkshire) produced most of the butter for the London trade. Doctors of the 16th and 17th Centuries frowned upon butter eating by adults but approved of its use perhaps for growing children. The northern peoples had an ancient proverb: "Eat butter first, and eat it last, and live till a hundred years be past."

Large amounts of cheese came into London from Cheshire, and London cheesemongers ran a fleet of 16 ships between London and Liverpool. There were several kinds of cheeses: Stilton, Wiltshire, and Cheddar. Daniel Defoe, author of "Robinson Crusoe," writes of cheddar: "In the low country, on the other side of Mendip Hills (England), lies Cheddar, a village pleasantly situated under the very ridge of the mountains; before the village is a large Green or Common, a Piece of Ground, in which the whole Herd of the Cows, belonging to the Town do feed; the ground is exceedingly rich, and as the whole village are Cowkeepers, they take care to keep up the goodness of the soil, by agreeing to lay on large quantities of Dung for manuring and inriching the Land. The milk of the Town Cows is brought together every day into a common room . . . where every man's quantity is set down in a book . . . and every meal's milk makes one cheese; so that the cheese is bigger, or less, as the Cows yield more, or less, milk. By this method, the goodness of the cheese is preserved and without all Dispute, it is the best cheese

that England affords. . . . " Cheshire cheese was often colored with "Spanish Arnotta," or anatto.

The nutrients in milk from cows and from animals of other species (Nutritional Reviews, 1948, **6**, 18-20) have been given ample laboratory study. Mare's milk is more like human milk than milk of any animal. The B-complex vitamins parellel roughly the protein content of a milk, and milk of humans, cows, mares, ewes, buffaloes, camels (and sows, elephants, and dogs) is very replete nutritionally.

Studies have been made comparing the inferior growth observed in rats fed goat's milk mineralized with iron, copper, and manganese, with the good growth of rats fed cow's milk similarly fortified with minerals. The poor growth on goat's milk was counteracted by a daily addition of 50 μg. of folic acid plus 0.1 μg. of vitamin B_{12}; or 0.5 μg. of vitamin B_{12} alone; or 1.0 gm. of fresh beef liver. Goat's milk was found to contain only traces of vitamin B_{12}, in contrast to the occurrence of two to three μg. of vitamin B_{12} per liter of cow's milk. The folic acid content of goat's milk was found to be very low, and comparable to cow's milk. Folic acid and vitamin B_{12} additions to mineralized cow's milk did not further increase growth in the young rat. The addition of vitamin C to the cow's milk diets produced a large increase in the vitamin B_{12} content of the livers. On the goat's milk diets, added vitamin C had no effect. Folic acid and vitamin B_{12} additions to mineralized cow's or goat's milk did not affect the rate of hemoglobin formation in the weanling rat or in rats made anemic on milk diets. The habitual use of goat's milk may exert some effects on stature and build.

The Greeks as far back as Aristotle were thinking about dietary constituents of foods. "Casein, fat, and water are all the known substances in milk," writes Aristotle. Amino acid patterns of milks and colostrum are very similar. The effects of feed on cow's milk have been given much study in the Land Grant colleges. Cereals produce the best fats in milk. Vitamins A and D depend upon feeds, and D content also upon sunshine. Milk is a good source of calcium. The minerals iodine and iron of milk are two constituents varying with feed, but vitamin C, riboflavin, and thiamin are always present in milks and vary little under American conditions. The volume of milk depends upon kinds of breeds and proper nutrition in feeding. Cattle down through the ages have been accustomed to many feeds. The Romans fed turnips to cattle and the English feed rutabagas, or "swedes," as they are called. Beets and a great variety of vegetation including pine needles have been fed, but the Vikings hit upon an unusual feed for small breeds of cattle which they often kept on their ships for ready supply of fresh milk. While they

carried cheeses and salt fish, they fed their seagoing, small, hardy cows fresh fish! The great Earls understood roughly the value of cod livers and antiscorbutics, as well as man's weak facets. When nutrition and courage gave out in stormy seas, one Viking Earl who settled in Scotland gave his seamen much gold. "We are rich men now and in no mood to die," cried the seamen, "let us bail and row with right good will."

Swine

The pig was a forest and swamp animal which did not eat grass but rooted for roots, ate nuts, shrubs, and flesh. Wild swine obviously have a long history but were not domesticated until the Neolithic Revolution, as we have noted. The pigs of the early Nile swamps were domesticated much later in the early dynastic period, but soon became taboo in Egypt and Palestine, paleopathologists tell us, possibly because of trichinosis and tapeworm. Swine in tropical countries were heavily infested with parasites. The early folk of the Indus valley hunted *Sus cristatus* for food, but whether it was domesticated is not known. In China since the early Neolithic of that region, the pig was the chief source of fat-protein food. The wild European *Sus scrofa* is found in the lacustrine sites; the turbary pig, *Sus palustris,* is derived from *Sus indicus* or *S. cristatus* and was introduced into Europe from the East. We have dealt elsewhere, Jensen (1949), with breeds now popular in the western world. Nomads never could drive pigs and so they had none.

Some species of wild hog are found on every continent but Australia. Hogs are quite primitive forms and most of their evolutionary changes up to the Blakewell period of feeding (200 years ago) were caused by changes in feed. Afterwards, intensive breeding and scientific genetical concepts of breeding, feeds, and feeding methods resulted in shaping the domesticated hogs of today. The *Sus vittatus,* a wild boar of the East, is found widespread in European Neolithic sites, from the Danube to Denmark. *S. scrofa,* as well as *S. vittatus,* furnished food for Neanderthals and Cromagnards. Curwen (1938) points out the varieties of *S. scrofa* (wild) and *S. palustris* domesticated during Neolithic times. *S. scrofa* of the Neolithic Revolution was probably the type species of hog domesticated in Hither-Asia, Egypt, and India, and is the species ancestral to our modern breeds.

S. scrofa, but not *S. cristatus* (indicus), an Asiatic Siamese species, is found in China and Mongolia. Swine history shows domesticated pigs in Anau, Turkestan, and Tell Asmar near Ur. Sumerian husbandry developed a good breed of hog, dish-faced as are modern hogs. The non-

Semitic Sumerians were pork eaters, A. Ungnad (1908), and ate many pork products.

Pigs abounded in predynastic Egypt, and all through the long Egyptian history. Herodotus, Polyaenus, and Heliodorus all cite much pork eating and sacrifices of pigs in the later days of Egypt. Under the Greeks and Romans the pig was taxed heavily and the swine industry waned. Today only the Christian Copts eat pork, except the cosmopolitan dwellers in the cities of Egypt.

Black-haired pigs were raised in the colder districts of Roman Italy, while the more tender white breeds could be raised in the South. Fed acorns and beans, hogs were fattened for sale, and Varro mentions with admiration that swine coming up for sale were too fat to stand upon their feet.

Freezing for certain times and at certain temperatures makes raw pork safe. Trichinae will not survive in pork treated by a special freezing method developed by the U. S. Department of Agriculture. The thickness of the cuts of pork, or the inside dimensions of the container, determine the length of time the meat must be subjected to a given temperature to destroy any trichinae that may be present. Pieces of pork or pork products not exceeding six inches in thickness must be stored for a continuous period of not less than 20 days at a temperature not higher than 5° F., or not less than 10 days at minus 10° F., or not less than six days at minus 20° F., to assure complete protection. For larger pieces, or packages up to 27 inches in thickness the storage period is doubled, except at the temperature of 5° F., when the period is increased only to 30 days, Dr. A. R. Miller (1951).

Positive identification of *Trichinella* in man has recently been made in Alaska, the Canadian Arctic, Greenland, Arctic Europe, and Siberia, Connell (1949). An epidemic of trichinosis broke out in Franz Josef Land in 1944. Some 51 per cent of a group of natives on Southampton Island gave positive skin tests for trichinosis in the summer of 1948, and 33 of 300 native Greenlanders attacked in 1947 died, apparently from eating walrus meat. One death and several serious infections were reported from Alaska in 1945 and 1946. Since dogs are too valuable to be used as food, except in emergencies, and sea mammals are protected by their habits from all but sporadic infection, the bear remains as the one important source of trichinosis. Fortunately, meat is usually boiled in the Arctic, except in periods of scarcity of fuel. This parasite is killed when heated momentarily at 132° F. A five-degree safety factor (137° F). is demanded by the Meat Inspection Division of the U. S. Department of Agriculture. It is difficult to explain the 51 per cent

incidence of *Trichinella* in the polar bear. It is suggested that terrestrial carnivores obtain the infection by eating the carcasses of other bears, dogs, and foxes. The holoarctic distribution of the parasite indicates an early origin.

Cobalt has been shown to produce the same speedup in the fattening of hogs as has been found in sheep and cattle, according to scientists at North Dakota Agricultural College, Fargo. Hogs fed tiny amounts of cobalt in carefully controlled diets put on more weight and put it on faster than hogs not having the added mineral. Doctors Earle W. Klosterman, W. E. Dinusson, Earl L. Lasley, and M. L. Buchanan (1950) report in the August 11, 1950 issue of *Science*, pages 168-169. Diets containing other trace minerals (manganese, iodine, iron, and copper), as well as cobalt, caused an even greater increase in weights of another group of hogs.

Although it is not yet known how cobalt functions in the body, it is possible that the metal is used by bacteria in the intestines to make vitamin B_{12}, which in turn boosts the processes of growth. For example, in fatty pork (a lean loin contains 15 per cent fat) the thiamin content is 10 times that of beef, but pork is a poor source of iron. Riboflavin is higher in the flesh of ruminants.

The superiority of pork muscle as a source of thiamin in human dietaries is well known. It is recognized, however, that variations of considerable magnitude frequently exist in the thiamin contents of various samples of pork. This would indicate that thiamin is not under physiologic control in the pig but depends more on its diet.

The actual cholesterol content of man's diet is of no importance in developing arteriosclerosis. The manner in which the body handles cholesterol determines the development of this clinical entity. Fats of animal origin are no longer suspect by authorities as a cause of arteriosclerosis or atherosclerosis from ingestion alone.

Sheep

Mesolithic and Neolithic folk of southwestern Asia and Asia Minor followed bands of wild sheep, and in early food-producing times sheep became domesticated with the other "barnyard" and field animals. Neolithic emigrants to Europe over the several routes brought sheep with them, the bones of which are widespread in European sites from the kitchen-middens of Denmark to the lakes of Switzerland. Probably sheep were domesticated in several areas of Hither-Asia. Bones of domesticated varieties are found in Turkestan (Anau) and a mosaic frieze from Ur shows a short-tailed, fleecy, and a long, broad-tailed,

woolless sheep (the latter may have been plucked, as was the practice before shearing was devised). Three types were found at Jemdet-Nasr, Hilzheimer (1936), one of which was a short-tailed, fleece-bearing sheep. All wild sheep have hairy coats with soft, fleecy underwool. In domesticated sheep the hair disappeared, especially in dry climates.

The earliest Egyptian sheep go back to Neolithic times and were a hairy type related to the hairy breeds of the East. About 1500 B.C. they yielded to a fleecy, fat-tailed type in the Delta and Upper Egypt.

During the time of the New Kingdom (1580 to 1050 B.C.) the Ram of Ammon type appeared, with heavy horns and long, thin tail, and much fleece. It is thought to have come in from Syria. Philologically the name *Avi* (Sanskrit) indicates a very old origin in south central Asia. A great diversity of views has prevailed among zoologists in regard to the ancestry of domesticated sheep. Some writers state there were 10 distinct wild species, while others have considered that parent forms numbered not more than two or three. With the exception of the bighorn sheep, which have never been domesticated, sheep are natives of west and central Asia and the mountainous regions of southern Europe. Many fossil remains in the Northern Hemisphere date from Pleistocene times. Breeds resembling mouflon, but reddish-brown in color, were found in Crete, Cyprus, and Greece. The Neolithic breeds in northern Europe may have resembled the primitive Shetland breeds which still survive. In the Swiss lake-sites a small black-faced breed (turbary or urial sheep) with goatlike horns was found. These sheep still survive in Hither-Asia, Crete, and Cyprus.

From the urial and mouflon breeds, three groups of domestic sheep have been developed, a finewooled Spanish breed, the middlewooled and longwooled types related to north European types, and the carpet-wooled breeds (karakul) of Asia, where they still remain, Lydekker (1912). Fertility in sheep is profoundly affected by nutrition during the breeding season and during pregnancy. Miller, Hart, and Cole (1942) show that dietary factors, low vitamin A, low protein, and low phosphorus from feed deficiencies affect fertility and life of the lamb crop, whereas the vitamin B-complex are produced in the rumen and deficiencies in the latter nutrilites do not occur in sheep and cattle.

Sheep were imported into Spain by the Phoenicians long before the Christian era. Spain, because of topography and climate, is very suitable for sheep, and sheep raising became the chief economic enterprise in Roman times. The "merino" sheep may have descended as a fixed breed from Syrian "Imri," crossed with Barbary and Italian breeds. Some students assert that the merino breed was a fixed type by the end of

Roman times. After more settled times in Spain, when the Moors had been driven far south by the King of Castile, the Castilian hidalgos became sheep barons of enormous wealth, like the Mexican cattle kings. The annual roundup was a time of merriment, like the Feast of Nabal of the House of Caleb, described in the Bible. The roundup rodeo and festival time in Central and North and South America have their roots in Biblical times; all the practices go back to the ancient Orient. Likewise, the feuds between settled agriculturist, cattle- and sheep-rancher are discernible in history beyond Biblical times in the Fertile Crescent.

A firm tradition of English breeders points to the origin of the merino from a crossing of Cotswold and Spanish sheep. After 1800 A.D. the merino breed was raised in all European countries as far north as Sweden. Captain John MacArthur, in 1797, introduced the merino breed into Australia and is considered by some authorities to have established the sheep and wool business there.

The sheep industry in New England also was established in the 18th Century. Owing to Crown restrictions, the smuggling of rams out of England became a lucrative business for American sea captains. In 1676 the Board of Trade in London heard there were large numbers of sheep in New England and that "Newport in Rhode Island could furnish wool to Europe." There were some 40,000 sheep in Martha's Vineyard and Nantucket alone! The last shearing took place in Nantucket in 1847. With the westward movement of livestock raising, Ohio had usurped the industry.

Horse

The horse first appeared as a domesticated animal in large numbers only with the Kassite invasions from the Persian plateau in the middle of the 18th Century, B.C. The spread of forests in post-glacial times caused the disappearance of the horse in Europe, and it did not return until forest clearance became effective, although the folk known as Battle Axe warriors and Corded warriors coming in from the East possessed tame horses. Many prehistoric European agriculturalists do not seem to have used the horse.

The horse, with other mammals, "ran riot" in the lush grasslands of Pluvial times. Most varieties were small, but some fossil finds indicate large horses like the modern dray horse. The horse is a product of the grasslands and grass is its natural feed. Only after the horse came away from the encroaching Mesolithic forests, where he subsisted largely on twigs and leaves, did he develop again from a small creature to the fine animal of today. The wild horses of Asia and the feral of our western

states still live entirely on grass and refuse to eat much concentrated food when first captured. When domesticated, the horse has been induced to eat many foods.

Horses, while eaten by Solutreans and Magdalenians, were not domesticated in inner Asia (Turkestan or Sinkiang). The wild horse, *Equus prschevalski,* survived there until recently. At Siyalk in northeastern Iran, horse bones are found, but hippophagy may not have been practiced. The horse also figured as sacrificial food in the North through Viking times, the rite being introduced from the East by the Nordic invaders. The horse appears in Kassite times (1800 B.C.) in Mesopotamia, in Egypt (1500 B.C.), and in China about 1400 B.C.

N. M. Prschevalski, the first Asiatic explorer of modern times, found the wild horse *(Equus prschevalski),* and the kulan *(Equus hemionus)* which is greatly prized by the Mohammedans, who say that its flesh is a great delicacy and much sought after. Its hide is most valuable for footgear. These desert hunters say jokingly that the kulan is most tenacious of life and, "After the animal has been flayed and its skin dressed, its tail still goes on lashing flies!"

M. de Vaux Philipau (1939) in his excellent monograph believes *Equus prschevalski,* or the tarpan of the Altai Mountains, once wild on the plains from the Volga to Manchuria, to be the progenitor of the present types of *Equus caballus.* A small herd of Polish tarpans in the forest of Bielowieza survived the ravages of World War I, and were protected in the National Park of Bilgoraski. He believes the horse of the Sahara *(Equus libycus)* to be distinct from the tarpan.

For many reasons the horse has endeared itself to savages and civilized men alike. Its flesh has been eaten in ritual and by folk whose economies have failed so far as protein foods go, but hippophagia has usually been decried as a pagan practice in Europe until recent times.

There is a factor in hippophagia which German and British veterinarians have observed. The exclusive consumption of horseflesh has the disadvantage of causing diarrhea, as was experienced in the war in China and in the Transvaal, Ostertag and Young (1934). According to Pfluger, this is due to the presence in the meat broth of a substance soluble in alcohol, which was found to consist of 75 per cent lecithin and 25 per cent neutral fat and cholesterin. The injurious effect disappears when the meat is cooked with beef or mutton fat. The meat is quite sweet, from its high content of glycogen (muscle sugar breaking down to glucose, 0.38 to 1.072 per cent). This high sugar content tends to produce high bacterial counts in horseflesh, especially when comminuted.

Dr. Charles Harrington observed in 1905 that unless the fat of some other animal or some starchy food is eaten with it, horse meat may cause diarrhea. This effect may have been obviated by supplementary meats and fats by the Solutreans of upper Paleolithic times, who ate large numbers of horses.

Horseflesh contains 21 mg. of niacin per pound, 0.5 mg. riboflavin, 0.5 mg. thiamin, 14 mg. iron, 1,050 mg. phosphorus, and 57 mg. calcium. Chemical analysis shows 337 gm. water per pound, 98 gm. protein, 11 gm. fat, 3.6 gm. carbohydrate (glycogen), and 4.5 gm. ash. The high glycogen, or muscle sugar content, imparts the sweet taste in horse meat, especially noticeable in some of the hamburgers sold in World War II days and after. Linolenic acid is found in horse fat and pig fat but only in traces in beef fat.

A Snake Indian chief, who was invited to join the Wyeth party enroute to Oregon in 1832, detected horse meat in the evening stew. The Indian spat it out and stalked away, saying "shekem," a totem name for horse, N. Wyeth (1899). The widespread sensitivity to injected horse serum and to horse dander or horseflesh appears not to be the same phenomenon, according to W. Hartmann (1941), who used 1,668 persons in his study.

Camels

From the time of Jacob in the middle Bronze Age (1800 B.C.) until the time of Elijah (900 B.C.), there was no serious language barrier in the Fertile Crescent. Commercial ties were close from Sumer to the Nile Delta. The ass was the chief beast of burden in caravans. The domesticated camel is not mentioned until 1100 B.C., although wild camels were common in northern Africa and southwest Asia. The early wild camel was nearly exterminated in the regions bordering on the Fertile Crescent during the Third Millennium. After Elijah's day caravans of camels kept open the commercial routes of the known world.

Camels, both dromedary and two-humped Bactrian, were Asiatic importations, Bedawin raiders using the dromedary against Gideon. Bones of both species are found at Anau in Turkestan and the Indus of *circa* 3000 B.C., but these animals may have been eaten. Camels now cannot survive except in domestication, and when transplanted to the American deserts did not thrive.

The two-humped Bactrian camel of the Gobi-Asiatic deserts works only in winter, when it develops its thick coat. It rests in summer to fatten. It can then travel for weeks on sterile desert, drawing nutrients from the humps and utilizing snow for moisture.

The single-humped dromedary camel of the Arabian desert feeds and works as the occasion demands. The Bactrian is taken in summer to feed on certain soils, containing as yet unknown nutrients which hasten shedding of hair. The new coat soon appears, which gives some protection from swarms of dangerous gadflies. The humps begin to stand up after the rainy season.

In case of the dromedary with reserve fat of the hump, it can go a week without watering, subsisting on salt bushes and parched grass. If vegetation is green, it can—after drinking its fill of 60 quarts of water—go without drinking for a month. This "living water bag" can be used by the traveller, under dire circumstances, for water. At the height of the hot season the camel must drink daily, which compels annual migration to oasis villages. Camel's milk is drunk both sweet and sour, but neither butter nor cheese can be made from it. A she-camel gives from one to four quarts daily according to her feed. Males are only kept at stud, since they are fierce and have less endurance.

The Dog

Baumann and Huber (1946) believe the first dog (9000 B.C.) was a domesticated wolf. The modern Norwegian elkhound appears to have descended from it, perhaps following its masters, the hunters of the Mesolithic. There were many races of the European wolf, differing in legs and skull. From these wolves all of the ancient primitive, large and medium-sized dogs are derived in different lines of descent. From the Rottweiler type, known in the Iron Age, came the bulldog, later the boxer. Greyhound-borzoi and St. Bernard pups show similar primitive skulls.

There were apparently differentiated races of dogs in prehistoric times, as found by D. Brentana, in the *terramara* of Parma. Haag (1948) found smaller dogs always associated with older archaeological strata in North America, and larger dogs with later archaeological horizons. The lower cultural levels contain small dogs and the more advanced, larger dogs. It is concluded that larger size could be the result of artificial selection on the part of these primitive people, who usually buried their dogs with human beings or made careful disposition of dogs in burials (like some moderns). The ancestral form of modern dog was a small wolflike canid of Pleistocene Age which probably appeared as a mutation. Because of its small size and its increased competition with other forms, this ancestral dog attached itself to man. There is no direct evidence of domestic dog in Europe and Africa before 8000 B.C., or in North America prior to 1500 B.C. We have noted that dogs

were eaten by the Hellenes and Mesopotamians in ancient times, and in recent times by Amerinds and Europeans. Ostertag and Young (1934) note that in Germany 8,094 dogs were eaten in 1912 and 3,379 in 1928.

Fowl

Most of the ducks, geese, swans, as well as other game birds, are known from the Pleistocene of the Northern Hemisphere. In North America the Canada goose, brant, mallard, pintail, teal, wood duck, redhead, canvasback, bluebill, grouse, and partridge thrived then as in pioneer days, Palmer (1949), and have changed very little. Hutt (1949) describes birds from the reptilian stages of the Jurassic of 150 million years. There are so many characteristics common to both reptiles and birds that they may be grouped as *Sauropsida*. In our precipitin studies of serums and egg albumins of birds, reptiles, and the Sphenodon, the close quantitative relationships were apparent. *Gallus gallus,* or red jungle hen of India and the East Indies, is thought to be ancestral to all barnyard chickens (genus *Gallus* of four species), resembling closely the brown leghorns, both hen and rooster. The polyphyletic theory of origin teaches that all heavy breeds originated in Asia. Poultry scientists usually teach that domesticated birds resemble closely the wild species from which they originated, i.e., ring-necked pheasants, ducks, geese, pigeons, and guinea fowls. The hen and rooster from the jungle fowl of India were introduced into the classic world about 600 B.C., where they were used for food, egg laying, divination, and cock fighting. The Roman dinner menus, one of which dates from Martial and Juvenal (100 A. D.), stated "from eggs to apples," as the American menus of the Gay Nineties stated "from soup to nuts." The egg was also used in veterinary medicine in treatment of oxen. Cato (De Re Rustica lxxi) declared that a universal panacea for diseases of cattle was "a raw egg swallowed whole to be followed next morning by an onion crushed in a half-pint of strong wine." "Let a fasting man see that the ox drinks this fasting, and let both man and beast stand while it is being swallowed."

Two hundred hens were considered a good flock in Rome, as one man with a child's help could properly care for them. There was a central hen coop (*gallinarium*), and cleanliness was insisted upon. The coops were coated with highly polished cement for protection against snakes and cats. Dough or mash of cereals was used as feed, and water-dishes were fitted with covers pierced with holes large enough to allow the bird's head to pass through.

The cock has crowed mightily greeting the sun since the dawn of European history, and the Gaulic-French totem is a world-wide symbol of good nutrition for mankind.

Fish and Shellfish

Fish, both fresh-water and marine, have been major and minor foods all through the Mesolithic, Neolithic, and recent times. The Mesolithic forest folk of Europe became adept at fishing with weir, seine, harpoon, and hook.

While some fish are rich in fats, most of the edible kinds are now considered "protein foods." The distribution of amino acids is similar to that in mammals and birds, O. M. S. Dunn *et al.* (1949). Glutamic and aspartic acids are major constituents of animal proteins, while some of the essential amino acids, like methionine and tryptophane, account for only a small part of the weight of any animal protein. Duck egg albumin may have six per cent or more by weight of protein as methionine. There are 10 essential amino acids (arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophane, and valine). In general, lysine, tryptophane, and methionine are the most important amino acids in evaluating the nutritive value of proteins. Fish and red meats are about the same, cooked, canned, or raw. The fat content of herring varies with season, sea, and year from 6 to 0.7 per cent, Mygind, (1949).

Fish are low in vitamin A content except, of course, that the livers of certain fish are rich in vitamin A. Folic acid occurs only in traces. Vitamin D content is very high. Several species of marine and fresh-water fish contain an enzyme, thiaminase, which destroys thiamin, and in raw, uncooked fish the enzyme is so strong that thiamin, or B_1, of other foods is destroyed in the stomach. Dr. R. S. Harris (1951) records that raw clams cause 50 per cent destruction of thiamin in the gastro-intestinal tract, when eaten uncooked with ordinary foods. Many of the Mesolithic peoples must have suffered some malnutrition from eating uncooked raw clams, mussels, cockles, shrimp, and lobster which contain much thiaminase. The periwinkle oyster, *Littorina litorea,* starfish, frogs, toads, birds, and mammalian tissues do not contain thiaminase, but both fresh-water and salt-water fish, like suckers, catfish, bullhead, carp family, herring, and whitefish contain the destructive enzyme. Salmon, trout, eel, bass, crappie, bluegill, perch, wall-eyed pike, cod, haddock, hake, and halibut are free of thiaminase. However, the muscle of all fish is free of the enzyme. Carp and clam appear to be richest in thiaminase content. Chastek's paralysis from the effects of thiaminase observed in man and animals is characterized by pathology of the central nervous system, much like polioencephalitis of man. The mode of action of thiaminase enzyme is to cause hydrolytic cleavage of the thiamine between the thiazole and the pyrimidine rings (Nutritional Revs. 10, 301-303, 1952). Plants which contain antithiamin principles are mustard

seed, wheat germ, linseed, ground fern, horsetail, and leaves of oak, birch, aspen, brake, and birdcherry.

Nature has made muscle similar in chemical composition wherever it is found, because these proteins perform similar functions.

Fish eaters do not lack a source of good protein, but the old theory of phosphorus-rich fish contributing to phosphorus-rich brains, and hence greater intelligence, was unfortunately exploded long ago. Wealth and wisdom depend upon proclivities other than dining on sea foods, delightful as they are. We may recall Mark Twain's counsel to a young author who asked Mark about a recommended fish diet to improve his mental status. Mark answered the question truthfully, saying, "Agassiz does recommend authors to eat fish because the phosphorus in it makes brain . . . For you we suggest a couple of middling-sized whales for the present, not the largest kind."

Shrimp, like other invertebrates, is rich in arginine, otherwise its protein is similar to meat, fish, and birds. Shrimp is also a good source of calcium, phosphorus (225 mg. per 100 gm.), and riboflavin; poorer in niacin, fair in iron, but lacking in thiamin. Glycogen, or "muscle sugar," which is a polymer of glucose, is found in large amounts in all tissues of the crayfish. The body wall stores glycogen as a reserve food, Malaczynska-Sucheitz (1947). Mollusk shells in all levels, from upper Paleolithic to Moorish times in a cave-site in Tangiers, were observed by Howe and Movius (1947). The tremendous shell-heaps of the western European coasts, islands, and the Danish sphere testify to the importance of shellfish as food in the various prehistoric cultures.

Captain Vancouver in 1793 saw illness and death on the western American coasts resulting from eating mussels and clams, Medcof, Gibbard, *et al.* (1947). Furk (1950) calls attention to many primitive economies which have been seriously dislocated by eating poisonous shellfish. The original source of the poison (which is said to have killed President Harding) is a dinoflagellate, *Gonyaulax catenella*, the cause of red water of the ocean and phosphorescence of sea-water at night. The mussels ingest these organisms and store the powerful toxin which Dr. K. F. Meyer discovered. There is no danger nowadays from commercial outlets of these foods, and the Food and Drug Administration has an official assay method for the toxin.

The parasitic infections of man living near rivers like the Nile and Ganges, and lakes and ponds of the oriental countries, are numerous indeed. Bilharziasis, a disease caused by flukes from snails, so devastating in its effects, is seen in prehistoric Nilotes and 20th Dynasty mummies, J. Bernstein (1947). It should be noted, however, that the

Egyptians all through their long disease-ridden history accomplished much for civilization, notwithstanding.

Clams and oysters are good sources of copper, iodine, calcium, phosphorus, iron, and manganese, and the fluorine content is about 0.65 part per million. The fat content ranges from 1.1 to 2.4 per cent, protein 8.8 to 9.8 per cent, and carbohydrate 3.0 to 3.9 per cent. Both of these shellfish are fair sources of thiamin, riboflavin, niacin, and pantothenic acid. Pyridoxin content is about 0.2 mg. per 100 gm.

The foods eaten by all food-producing peoples from the Near East to Britain and Norway varied in patterns of items, but nutritionally the basic pattern was cereals, vegetables, fruits, red meats, fish, and shellfish.

Insects as Food

A food of minor importance may be described at this point. Locusts and other insects have been eaten all through man's era from the earliest times, and (in a few instances) to the present. Classical Athenians had a grasshopper totem and Salt Lake City has the gull totem. In Hither-Asia and Arabia the desert marginal peoples were sometimes called the "locust eaters" and the usual descriptions of these folk picture them as short-statured and tough! In gathering locusts they produced smokes which arose from the arroyos or ravines "blinding" the insects, which fell in great rifts. The locusts were then collected, pounded with salt, and made into cakes for roasting. Herodotus tells of the Nasamonians of Africa who collected and ate locusts.

Aesop notwithstanding, the grasshopper and locust were not the antitheses of ants. The Japanese have found the locust even more nutritious than fish, and the American naturalist, Dr. Wilfrid S. Bronson, has boiled and eaten them for the sake of Science. He says they taste like lobster! The desert Indians of the Great Basin carried on great grasshopper or cricket drives. Ditches were dug, covered with grass, and beaters, men, women, and children slowly drove the insects to the ditches, in great masses. When the ditches were teeming, the dead grass was fired, leaving the trenches half-full of dead and legless crickets. Squaws gathered the hoppers in large baskets. When dried out, the insects were ground into a fine flour and baked into a pancake about two inches thick and 10 inches in diameter. Hoffmann (1947) tells us much of various species of *Coleoptera, Lepidoptera, Diptera,* and *Hemiptera* used for human food today, especially in China. Hunger has driven man to many sources of food. We, of course, eat honey of insect origin. Metcalf and Flint (1939) point out that primitive man ate grasshoppers, crickets, beetles, walking sticks, caterpillars, pupae of

moths and butterflies, termites, ants, cicadas, bee larvae, eggs of aquatic bugs (old Mexican delicacy), and crane flies. They also believe, from the actions of wild animals and the testimony of those persons who have tried insects as foods, that much of this material is palatable. They further state that it would, in fact, be difficult to give any sound reasons why we consume quantities of oysters, crabs, lobsters, and shrimp, and disdain to eat equally clean, palatable, and nutritious insects. Perhaps the economists of the future, if hard-pressed to maintain an ever increasing population, may well turn their attention to the utilization of certain kinds of insects as human food.

Goodwin and Srisukh (1949) found the locust (*L. migratoria*) provides a good source of beta-carotene, or provitamin A, in amounts similar to those found in green vegetables, and that it is better utilized than plant carotene. The vitamin A content of a single adult locust averages 35 μg., and a handful would provide the daily requirement of this vitamin, as well as a fair source of protein, carbohydrate, and some fat. These data testify to the nutritive value of the insecta, even without the wild honey also eaten by the Hebrew prophets of the desert, like John the Baptist.

CHAPTER X

Spread of Food Production to Europe

Routes into Europe

We have seen that populations of predominantly Mediterranean folk increased markedly with food supply (wheat-barley-meat-milk) and after perhaps two millenniums in a drying climate these advanced food producers invaded Europe from along the North African coasts to Spain, thence to the Swiss lakes and the Rhinelands. They carried with them wheat, barley, the pig, sheep, and cattle, spreading over western Europe and into England. Moving up the Danube, others met the slowly infiltrating streams from northward over the Pillars of Hercules. Still others, by way of Crete, Greece, and the Bosphorus spread by sea to all the northern Mediterranean lands. Later, the Megalithic peoples came by sea through Gilbraltar, along the western coast of Europe to the British Isles and Scandinavia. Denmark was a cosmopolitan center in Megalithic times (2000 B.C.) with mariners and their ships arriving and departing for British, Irish, and European settlements. There were Danubian merchants with their trade ware, tall Nordics, and a few rufous Mesolithic survivors selling their amber. Here and there in small compact groups lurked the Battle-Axe warriors from Holstein and Germany who soon invaded Jutland, Sweden, Poland, and Finland, diffusing their Aryan or Indo-European speech, diets, and culture. Some European specialists on this era state that the Aryan speech and ethnic strains of these warriors were derived from the Gravettian hunters of upper Paleolithic time (South Russia) rooted in the Mesolithic.

When we consider the Neolithic settlement of St. Kilda beyond the Hebrides, 50 miles out in the Atlantic, we must realize that early folk were daring and fearless migrants. Today St. Kilda is abandoned as too remote for human habitation!

Then the Battle-Axe, or Corded peoples (so-called from their pottery decorations), from South Russia, traders and farmers, came into the north of Europe. These folk, together with the white and rufous Paleolithic and Mesolithic survivors, are the compost of European peoples today. There were few dark whites in the European compost, except in eye and hair color, although where the Neolithic invaders were settled densely we find today the brunet Mediterraneans to be in majority. Many anthropologists postulate that in a sense the Nordic is composed of pigmented and blond phases of the Mediterranean,

"blended" together with other Europeans of great antiquity. Certainly, the remains of the early Sumerians, who were the first great dairymen, cannot be distinguished in skull and face from some living British folk. These invaders of Europe, however, left the great centers of the Fertile Crescent before the Age of Metals.

The "Corded," or "Battle-Axe" folk, or at least their culture, according to Glob (1944), influenced the people later called Celts, Teutons, Italici, Illyrians, and Slavs. This culture is discernible also in Greece and the lower Balkans. V. Gordon Childe (1948) thinks it possible this culture might have arisen in Denmark, central Europe, or south Russia, or at any point on the European plain where the older forest folk met the oncoming Neolithic cultures. Coon (1939) suggested they were Neolithic racketeers. Their burials were close to the sources of natural wealth of the times like salt, amber, and later tin.

British Isles

Prehistorians discern many movements of peoples into pre-Roman England, Wales, Ireland, and Scotland. When Scotland became inhabited with the final retreat of the last ice sheet (10th to 12th millennium before our era), a "harpoon people" of Caucasian stock found their way there (8000 B.C.). Before the Second Millennium, B.C. a "Beaker" people were crossing the North Sea into eastern Scotland, while western Scotland was receiving "longbarrow dark-haired" (Picts?) settlers who came up from Spain and Brittany. Thick forests kept these folk apart for a long time.

Curle (1941) studied a pre-Bronze Age site which he described in his article, "Two Thousand Years of Home Life in Northern Scotland." At the extreme southern end of the mainland of Shetland towers the massive headland of Sumburgh Ness. Sheltered behind the Ness is Sumburgh Voe, a calm stretch of water running about one mile inland, which is a site of ruined buildings called Jarlshof. After a violent storm some forty years ago some buildings on the shore were exposed, dating from pre-Bronze Age (Neolithic) down to the Viking Age (800 to 1100 A.D.).

Troughlike quern-stones were found, with the rubbing-stones nearby. Soapstone vessels and pot sherds, stone tools, and slate skinning-knives, like those of Norway Arctic culture, were also found. There was no evidence of spinning or weaving (3000 to 2000 B.C.). There were molds for bronze casting of swords and axes. The advent of the swordsmith trained in Irish-Britannico traditions did not synchronize with any ethnic or other cultural change. Barley was found and shell-middens of

limpet, and a Danish Maglemose chisel. There were no fishhooks or spears.

From 800 B.C. Celtic-speaking peoples from the Continent (southwest Germany and upper drainage of the Rhine) spread as rulers into France, Spain, and finally to the British Isles. While on the Continent their language had divided into two branches—Q-Celtic (Gaelic)—Irish, Scotch, Manx; and P-Celtic (Brythonic)—Welsh, Cornish, Breton, British, Galatian.

Some four centuries before Roman Britain, Celtic tribes invaded southern Scotland, giving new rulers and new speech. These Irish "Scots" settled at Dalriada. When St. Columba (521-598) taught these folk to read the Bible in the Gaelic tongue, the Dalriadic "Scots" language became dominant. Afterward, the Danes and Norse in the Ninth Century, A.D. held a dominant hand until their symbolic defeat at Largs in the 13th Century, after which time English speech of southern Scotland became the official language. The Anglo-Saxon colonization in the Sixth Century from the Tees to the Forth, the Welsh-speaking kingdom of Strathclyde, and the Picts on the north of the Forth-Clyde line, all furnished ingredients of the modern Scot. The Celtic spirit of the Highlands is still strong. Sir Arthur Keith (1949) has pointed out that it has taken 10 millenniums to build all the Scottish nation from peoples who came originally from all the countries of western Europe—Norwegians, Danes, Germans, Flemings, Dutch, French, Spaniards—to say nothing of the Beaker folk, harpoon people, and the longbarrow type. They were all Caucasians and so alike that an expert anthropologist cannot distinguish skull and skeleton of one "race" from another, be they Celtic or Gothonic in origin. What is true of Scotland is true also of all the nationalities of Europe, but their ethnic compost is made up of different proportions of genetical elements.

The ethnic and nutritional pattern of Wales is much like that of Scotland: first, Paleolithic cave men; Caucasians from the southwest of Europe in Neolithic and Bronze Age times; the P-Celts imposing their language in the Fourth Century B. C.; Saxon, Viking, and Norman pounding on frontiers and seacoasts; and the imposition of the English tongue by Edward (1272-1307).

Archaeologists are agreed that Ireland received her first men in the Sixth Millennium, B.C. It is possible that before that date food-gathering men penetrated into northern Ireland from the British mainland, but nothing definite is known of them. From 6000 B.C. to 2200 B.C. little is known except that the land was a paradise for food-gathering folk. Towards the end of the Third Millennium, B.C. emigrants from France,

Spain, and Mediterranean lands came up to the Irish Sea and settled in both Britain and Ireland. They were stock raisers (sheep-ox, swine, goat, dog) and introduced tillage (wheat-barley, flax, cabbage, parsnip). It is not clear what happened to the earlier food gatherers, but Dr. Coon (1939) believes that these people with light eyes, large, long heads, often with rufous hair, good stature, and great strength transmitted these characteristics to the modern Irish. From the Second to the First Millennium, B.C. emigrants kept coming from southwest Europe, and others from central Europe. These folk were metal workers and Ireland became very prosperous. About 400 B.C. the Goidels (Milesians, Scots), from central Europe originally, reached Ireland from Spain and, after long campaigns, imposed their tongue from Cork to Donegal. Each tribe remained apart under its own chief. In the 5th Century Christianity reached Ireland. There were 185 tribes (Keating states 110), forming 13 confederacies. In the ninth and 10th Centuries the Danes settled in large numbers along the seacoasts at the mouths of rivers. The Normans came in later, then the English, and in 1937, the determinate policy—a government which did not neglect its antiquities, and which financed large-scale archaeological research.

The English ethnic and nutritional pattern is not much different from the other nations of the British Isles. Sir Arthur Keith (1949) and Professor Hooton of Harvard, believe that inhabitants of the British Isles are the most homogenous of all the peoples or nationalities of Europe, since they have inbred since the Norman Conquest with no great increment of foreign blood. There are many local differences in types and dialects. For instance, in Yorkshire, especially in the coastal fishing villages, where the dialect contains much Danish and where older fishermen still wear T-shaped amulets around their necks recalling Thor's hammer, Norse types are common. The same types are observed frequently in the Orkneys, Shetlands, and the Scottish Islands, i.e., Hebrides, Colonsay, Oronsay, Man, etc., and the Irish Aran Isles, recently studied. Cranial studies of the plague pits (Great Plague of 1666 A.D.) of White Chapel, Moorfields, and Farringdon Street, London, showed the people of Defoe's London to be Iron Age Nordics of Celtic variety, and ancestral to the modern cockney.

The Spanish Peninsula siphoned the culture of coastwise North Africa and South Mediterranean coastlands which first put their impress on resident food gatherers. The Neolithic folk around whom forests still flourished, introduced hoe culture of cereals, stock breeding, olive trees, and perhaps grapevines, but wild varieties did exist. The grain-reaping implements, silos, and saddle-querns, as well as wattle and daub huts, were like those of the Neolithic Fayum.

From the Mediterranean through the Garonne and Rhone valleys, to central France and the English Channel, these villagers cultivated barley and wheat; bred horned cattle, pigs, goats, sheep; hunted game and fished; lived in oval huts; were weavers and pot makers. Their cattle were both large and small breeds. Oysters were imported from coastlands. Trephining skulls of the living was practiced. Brittany and the Channel Islands show a variety of cultures (standing stones, tombs, etc.), since these areas were the ports of call from the Iberian Peninsula to British and Irish tin mines and gold fields. Their foods were cereals, flesh, fish, mussels, and apples.

Great Britain and Ireland were already populated with Mesolithic hunters and fishers. The Neolithic colonies of South England did not borrow any of the Mesolithic culture. The Windmill Hill culture near Avebury of French origin consisted of camps where families returned from their roving quests for shellfish, fruits, berries, and deer, to the stay-at-homes who bred large cattle of crossed shorthorn and ox (*Bos primigenius)*. They kept sheep, pigs, goats, grew wheat and barley. They dressed hides for leather and used pottery.

The Megalithic culture, originally from Southwest Europe, superseded in part this Neolithic culture in England, Ireland, West Scotland, Man, the Hebrides, Orkneys, and Denmark. Their foodstuffs were calves, sheep, game, horses, and cereals. These dolichocephalic folk were traders and metallurgists.

The round-headed Beaker folk invaded in complex movements from the Rhine and France, occupying the English lowlands and eastern Scottish coast and contributing greatly to the Bronze Age culture. They grew cereals mainly, but raised domestic animals, especially sheep. They were traders and may have begun building stone circles like Stonehenge and Avebury. During these times Egypt and Mesopotamia were in the first rank; Asia Minor and the Aegean World not as developed as the Fertile Crescent, Iberia, central Europe, and southern England in the Bronze Age; while Scotland, the Isles, and western Scandinavia were Neolithic.

The Danubians

The oldest Danubian settlements on the loess soils from the Meuse River to the Vistula in Russia, and as far north as Denmark and the Baltic Sea, all show mixed hoe farming—wheats, barley, flax—and livestock: cattle, pigs, and sheep. They seemed not to have eaten game at all and possessed few tools of the chase. At Koln-Lindenthal near Cologne a typical village-site has been excavated, showing their barns

and rectangular-gabled houses. When their fields or plots became less fertile they shifted to new, uncultivated areas, for they had much "elbow-room" and did not practice manuring. Dung of domestic animals appears not to have been used as a fertilizer in Europe until the late Bronze Age, and became generally used during the early Iron Age. Field fertility tended to anchor a community and stimulate new technological advances in food production, like plough cultivation instead of slash-and-burn hoe tillage. Some fertility of soil did result, however, from the slash-burn of forest trees, with the resultant wash of ash into the soil. Later on, another group of Danubians came into the old site, but these folks were on the defensive. They fortified their villages with ditch and rampart against the "Westerners," whom we saw in the pile dwellings on the Swiss lakes, in England, and on the Rhine. These invaders possessed stone axes and their tools and pots were those of the Fayumis. Archaeologists believe the Westerners' culture, at least, was derived from North Africa.

Danubian food-producing cultures were founded on the well-watered and drained loess soils which could be farmed easily. Throughout central Europe a primitive food production developed. Danubian I economy was based upon cultivation of einkorn, barley, emmer wheats, beans, peas, lentils, and flax. Hoe cultivation was employed. They possessed small herds of ox, sheep, and pigs. They did not hunt. After their grain plots were exhausted, they moved on to nearby uncultivated sites. They lived in pit dwellings, had granaries 90 by 20 feet, and barns, all surrounded by palisades. Articles of trade from Africa (ivory), and the Aegean and Adriatic to the Baltic, were probably carried by travelling merchants, forerunners of the bronze merchants. The Danubians were a peaceful folk—apparently of Mediterranean stock, but mixed with indigenous peoples, as might be surmised from all precedents. The Danubian II, a slow expansion into central Germany and Galicia, was founded on stock raising, hoe cultivation, and hunting (3000 B.C. to 2200 B.C.), coming into contact with food gatherers of the Tardenoisian, Maglemosian, and Swiderian cultures. In Period III, expansion led to a great variety of small, conflicting groups of the periphery, as well as intruders (Beaker folk, Battle-Axe-Corded folk, and Nordics). Loess soils of Central Europe also supported light, mixed oak forests. Slash-burn and felling of trees with polished axes, together with grazing animals and cultivation, made for a relatively comfortable existence until soil exhaustion over large areas may have led to pastoralism and the rise of the warrior class. Also, the domesticated horse, controlled with bit, and war equipment, are in full evidence. The sites of these cultures ("Baden") were often on hilltops, with cultivation of bread wheat,

einkorn, sheep, cattle, and pigs for food (2000+ B.C.). There were also hunting and fishing.

In Period IV, or Early Bronze Age, war demanded the better implements of metal forged by metallurgists of Caucasian tradition. There were travelling merchants dealing in salt, amber, faience beads, and gold. The amber routes are described by Nansen (1911) extending from Jutland, East Prussia to the Saale Valley, thence through Bohemia through the Brenner Pass to Italy and the Aegean. The Black Earth region between the lower Danube to the Dnieper was a region of forested plains, with a fauna of deer, wild boar, elk, waterfowl, and doves. The black soil then, as now, was very fertile and a series of cultures developed based upon farming and hunting. The foods consisted of millet, wheats, fish, horse, cattle, sheep, goats, pigs, deer, chamoix, boar, bear, and lynx. There was much pottery, and battle-axes and bows and arrows were used. In some areas (Tripolyte) the wheats were *T. vulgare, T. compactum,* and *T. monococcum.* Other cereals were barley, millet, and rye. They also ate elk, red deer, beaver, wild ducks, mussels, fish, and acorns. Horse bones are numerous.

Spread of Food Production

The Minoan food supplies (of Crete) before 2000 B.C. to 1200 B.C. were cattle, goats, pigs, sheep, cereals (wheat, barley), olives, and fruits. In Anatolia, Asia Minor, the economy coming from the south was cultivation of the cereals: wheat (einkorn, emmer), barley, and millet; and vegetables, vines, fruit trees; cattle, sheep, goats, swine, and fish. In Neolithic "A" of Greece (no Paleolithic sites have yet been discovered on the Greek Peninsula), the peasants living in small hamlets cultivated barley, wheat, figs, pears, peas; cattle, sheep, goats, and swine. They used saddle-querns, textiles, and pottery. Neolithic Macedonia was cold in winter and heavily wooded. Red deer were hunted. The peasants lived in permanent wattle and daub villages and mud-brick huts warmed by clay ovens.

The great European plain in the Neolithic inherited its cultures, stock, and cereals from the South and Southeast. The very complete archaeological record from Denmark shows the food-producing economy evidence in imprints of einkorn, emmer, and barley on the "Corded" pottery. The Corded, or Battle-Axe (stone), folk decorated their pottery while still wet, with cord impressions. The saddle-quern was used for grinding.

The Battle-Axe folk and their fusion elements from preceding Ertebolle and the Megalithic, lived in rectangular houses, bred cattle,

sheep, horses, pigs, and were hook-and-line fishers. They raised flax also. The new elements of Europe were composed each in themselves of cultures of peoples who spoke Indo-European languages or Aryan, from which Sanskrit, Gothic, Greek, Russian, Latin, Lithuanian, and Welsh have been descended. The diffusion of food production was northward, not the reverse.

Stone axes do not denote lack of technology. A few years ago in Denmark a carpenter using a Neolithic stone axe logged 26 pine trees (eight-inch lumber) in 10 hours. Then, with (Neolithic) stone axes, planks and timbers were hewn and a house was built by the one man in 81 days.[1]

The Neolithic folk of Sicily and South Italy lived in multitudinous small hamlets and natural caves. They ate cereals, cattle, sheep, goats, pigs, shellfish, and hunted game with spears and slings. Some of their pottery (Syracuse) resembles the grand style of Denmark, but their cultures are derived from the South Mediterranean (2000 B.C.). The physical types are Mediterranean, but near Palermo are found some brachycephals. In the Neolithic and Bronze Ages, cultures of southern Italy are much the same as in Sicily. In North Italy the Neolithic lasted in Liguria until 500 B.C., but the Bronze Age of the Po Valley shows economies based on plow farming, fishing, and hunting. Their pottery dates about 1500 B.C. There were diffusions from the South and undoubtedly from Egypt, since the famous sword of Pharaoh Seti II (1198 B.C.) is like those found in North Italian settlements.

Marginal Europe

In Scandinavia and Denmark successive movements of peoples during the Neolithic make this region, according to Scandinavian archaeologists, one of the most complex and most mixed ethnic sections of Europe. The old Ertebolle regions of Denmark and southern Sweden became the home of a dense population of very successful hoe farmers and cattle breeders. The coastal food gatherers resident from the Mesolithic kept at their old fishing and hunting sustenance patterns but eventually mixed with the new immigrants. The climate was drier and warmer than at present, and Shetelig, Falk, and Gordon (Scandinavian Archaeology) show a 4°F. increase in annual mean temperature at that time. The Megalithic invaders, the Battle-Axe peoples, the Mediterranean peoples from early Britain, Borreby-Brunn Alpine types of Paleolithic, and Mesolithic folk like the Ofnet of Bavaria and Aflou of Algeria, Cromagnons and many

[1] Dr. W. F. Libby (1951) by radiocarbon dating found a summer house made of birchwood in Denmark to be 9479 ± 280 years old.

more, contributed to the present Scandinavian types. The common foods eaten in these times were fish, shellfish, eels, large fowl and their eggs, beef, pork, deer, horse, sheep, and small game. The cereals were emmer, einkorn, and barley. There were some fruit trees found in Sweden, apples usually, and berries and nuts were eaten to a lesser extent. The conifer and spruce forests furnished gum, which was known to have been chewed by food gatherers of the East Baltic regions.

Northern Britain, northern Norway, and northern Sweden were areas of isolation during the Neolithic, and diffusion of culture was slow. East of the northern European forests there was little technical change across Siberia to America. Most authorities have not dated the beginnings of the Neolithic in China, but a date which soon may be found wrong is 2500 B.C. The earliest known Chinese grain is millet and the earliest domesticated animals the dog and pig. Wheat and rice were later arrivals and there are yet no indications of sheep-ox, or wheat-barley patterns of agriculture. The rice culture may have diffused from central India. The wild plant is found from India to Indo-China. Giant millet (kaoliang) was the chief grain and was eaten as porridge and cakes. These early people used hemp textiles and cooked in pottery. Later in South China we find cauliflower, cabbage, spinach, onions, and sweet oranges which were introduced into South Asia. The lemon came from the Mediterranean to the East, but the banana came from South Asia (seen by Alexander's armies) and Malaya, where it was cultivated in pre-history.

The Alpine Lake Dwellings

The lake dwellings of Switzerland and elsewhere were the first well-known records of a western culture of Neolithic origin. There were nearly 200 lake dwellings in Switzerland alone. Dr. Ferdinand Keller (1856) first studied the site of lacustrian pile dwellings, or palafittes, in the dried-up mud flats of Lake Zurich during the drought of 1853 to 1854. In the mud were found flint tools, horn, bones, and burned piles. His publication inspired others, who found palafittes in France, Italy, Germany, England, Sweden, and Holland.

The Swiss lake dwellers' culture was a mixture of local Mesolithic and North African Neolithic, with perhaps a Danubian element. Later, according to Dr. C. S. Coon (1939), a Corded element came in from the North. These mixtures are seen as both longheads and brachycephals, and also many disharmonic forms. Dr. Vouga (1928), of the University of Neuchatel, has described these completely Neolithic communities of farmers who lived in rectangular wooden houses, raised on piles and

strung out along the lake shores. These villages probably were built beside the lakes, not over the water, but the stilted marginal villages were flooded during a cycle of increasing rainfall. With flood and onslaught of the Warrior tribes from the Northeast, migrations began across France, some going up the Thames estuary and settling there with their pile villages. There was some cannibalism, as we have seen, in all peoples, from the beginnings of Man down to recent times. The skulls were dolichocephalic in the oldest settlements. These farmers cultivated emmer wheat, *Triticum compactum*, barley, linseed, caraway, carrots, poppy seeds, beans, lentils, plums, apples; brewed cider, and raised horned cattle (*Bos brachyceros*, some *Bos primigenius*), pigs, sheep, and goats. The bone finds show oxen 39 per cent, swine 21 per cent, sheep 18.5 per cent, goats 18.5 per cent, and game 30 per cent. There were also present bones of wild horses. The cattle were stalled and the manure used for fertilizer. They employed hoe culture, not plow, netted fish, and speared fish with antler harpoons. Flax was cultivated for linen, skins were processed for clothing, and leather and pottery made for cooking vessels and storage.

The Robenhausian lake-sites, nearly a mile out, show dugout canoes and stone slings—the kind David used to kill Goliath, and the Russian Tartars employed at the siege of Sebastopol. Their bread was unleavened, like our buckwheat cakes. Wine, however, was fermented, from raspberries, cherries, and mulberries.

The dwellers in Lake Constance palafittes and in the moor villages, protected by ditches and palisades north of the Rhine, hunted wild horses during the Atlantic phase of climate. Pottery was used, and hoe cultivation of the then common cereals. At some distant date Lake Neuchatel flooded, destroying the early settlements, and a new Horgen culture was founded by a new people who were hunters and bred some livestock. Their houses were small with peaked roof. They used coarsely-made but serviceable pottery. At Robenhausen in the moor, which was formerly the old bed of Lake Pfaffikon, very sooty cooking-pots were found.

The successors of these folk on Lake Zurich were the Battle-Axe culture peoples. In the eastern Alpine region the lake dwellings and hill camp-sites show cereals were raised, and the Austrian lake-sites show that apples and beans were also eaten, as well as beef, pork, mutton, horses, game, and fish. Milk jugs are found; the pottery is coarse. So far as their sustenance, or food pattern, goes, H. G. Wells stated that 19th Century peasants of Germany, Switzerland, and France lived much like these farmers of 4,000 years ago. When the pastoral tribes of Europe learned to fertilize their fields, they could remain settled longer in

one place. Nearly all the animals now domesticated (in Europe at the close of the Neolithic) had been domesticated during the Neolithic of Hither-Asia. The hen from India, and domesticated horse from the Kassites, came in later, in the civilized Near East and eventually to Europe.

Some pile dwelling communities survived to Gallo-Roman times all over Europe. Herodotus describes these settlements at Lake Prasias, and palafittes on mounds and swamps were called terramara in Italy and terpen in the Netherlands. During the drought of 1921 the Morges site, the largest station of Lake Geneva, was exposed to sight.

It is not clear whether aerial pests like malarial mosquitoes could be partially avoided if prevailing winds were favorable, but the palafitte afforded protection against enemies and wild beasts. The settlements often housed several hundred people. They were diligent folk like their modern descendants. Over 100 bushels of wheat were found recently during excavations of the lake bottom of Wangen Village.

The Bronze Age

The Bronze Age lasted about 1,500 years in the Fertile Crescent and about 600 years in Europe. Modern authorities find that the designation is merely a tag to include a period of the late Neolithic economy, when copper and bronze began to supplant some of the weapons and tools of stone. In Denmark, for instance, a family might be Neolithic and Bronze Age in culture. The period saw many complex movements of peoples from an Aegean center to Spanish and Danubian centers and thence to the west and north. Copper came from Spain, the Carpathians, Caucasus, and Cyprus,[2] while tin came from England, Spain, and Bohemia. In Cyprus, Asia Minor, and Palestine, about 2000 B.C., a new people appeared—roundheaded, tall, with very prominent noses, thought by some authorities to be the Dinaric group originating in Syria. They travelled about Europe with their bronze industry. From Spain they moved to the Rhine and central Europe where they mixed with the Borreby-Alpines and the Corded peoples, then these mixed peoples crossed into Britain. Some of these folk came into Ireland from Spain, and Scotland received both streams.

The Neolithic folk of Europe traded their valuables for bronze knives, swords, and pots and pans. The Danes traded amber, which travelled from Denmark to Saxony, to Bohemia, Austria, and over the Brenner Pass to Italy. Bronze Age smiths settled in the European

[2] Bronze derives its name from Brondisium, modern Brindisi, Italy; Cyprus, the early *Cuprus*, copper.

communities, forming little blocs in the barbarous villages and stockaded strongholds. The climate of Neolithic Europe was wet and warm and great rain forests grew, but during the Bronze Age the sub-Boreal climate was drier and the rank forests gave way to prairies and steppes. On the great northern plains people again resumed pastoral nomadism and the older civilized centers of the Fertile Crescent, relying on their irrigation, experienced great disturbances from tribal migrations. The horse makes its appearance in the valley of the two rivers during the middle of the Bronze Age through conquering horsemen of the East, and the Dark Age of Babylon closed in through conquest. The Hyksos tribes conquered the Delta and the entire kingdom of Egypt. Everywhere were movements of people caused by general drought. The farmer turned to nomadism. The Egyptian monuments of this time show many blond Nordic types among the Asiatic invaders. Homer's heroes all fought with bronze weapons. Peoples similar to the Battle-Axe and Megalithic of Denmark and Sweden are found in Greece of the mid-Helladic. Greek literature and art furnish the picture of both blond and brunet gods and heroes, as might be expected.

The Scandinavian Bronze Age began about 1500 B.C., for there were no metals available except through trade. The amber of Jutland was traded for gold and bronze. The people were preponderantly long-headed and tall, although many blends of long- and round-headedness were in evidence. Some of the Danes were blond, as is evidenced by the Egtved find in Jutland. The remains of a young woman were found, mound-buried in an oak coffin. Her blonde hair was cut short over the forehead and hung in a long bob at the back. The clothing, teeth, and hair were preserved, but the bones were lost, L. Coutil (1930). A birchbark pail found in an oaken coffin burial of the Early Bronze Age contained a sediment shown to be cranberry wine, to which honey and myrtle had been added.

The first Bronze Age men to reach England, the roundheaded Beaker folk, have been well traced on the Continent by archaeologists as coming from Spain and spreading up to the Atlantic Coast as well as North Italy and central Europe. In the Rhinelands they mingled with the mighty Battle-Axe peoples, who established their Aryan language from India and the Black Sea lands to the Baltic. These restless folk, who also used fine bows and arrows, depended for their basic foods on their herds, but grain farming was employed to a minor degree. They were tent- and hut-dwelling semi-nomads. Their pots were largely drinking beakers and they are believed to have used fermented drinks to establish mastery over peoples they invaded. They seem to have founded Stone-

henge and Avebury—since sky-gods were worshipped rather than the Earth Mother of the Neolithic grain growers (like Demeter of the early Hellenes). They broke up most of the little isolated communities, some of whose villages like Skara Brae in the remote Orkneys have been excavated recently. The hardy Skara Brae folk, in their inhospitable climate, tended their small herds of cattle and sheep and dug shellfish, of which there was an abundant supply; caught seafowl, gathered their eggs; caught fish; hunted deer; but seem not to have grown grain. They had no metal and there was no need for warfare. The Beaker folk eventually crossed over and the eight little households disappeared under the sands.

In the middle Bronze Age Britain and Ireland saw numerous cultures blending uninterruptedly, among them the Peterborough folk of the Food-Vessel cultures, who at times practiced oak coffin burials or dug-out boat burials, especially in Scandinavia; and the Urn people, who practiced agriculture by simple hoe cultivation (barley, wheat, flax), raised sheep, and made fine woolens, some of which have survived in contemporary Denmark. The Danish oak coffins buried in bogs, when opened today, show preserved suits of clothes complete in detail. Men (one with red hair and beard) wore round woolen caps, long cloaks hanging in graceful folds from their shoulders, and kirtles to the knees, held with woolen girdles. Women's fashions demanded cloaks but short-sleeved jackets and long skirts, and one woman increased her yellow hair by a concealed hair-pad! Her hair was held in place by a very intricately woven horsehair net of fineness similar to the hairnets seen today. Women wore bronze and golden bangles and jewelry, as in the Indian Punjab.

Their foods were basic and adequate. All of these folk had at their disposal meat from domestic herds and game, fish, shellfish, eggs, milk, barley, wheat, nuts, and berries, cherries and apples in season.

By 1000 B.C., when the late British Bronze Age opens and the 1,000 years covered by this age and the Iron Age are past, we discern the peoples of Europe with much the same ethnic groupings seen in better-documented historical times. Europe was largely dominated by the "Celts" of many types, as well as inhabited by "Nordics" of complex groups, "Alpines," Dinarics, and Mediterraneans. Their basic foods were the same: barley, wheat, rye, cattle, pigs, sheep, fish, shellfish, game, and the seasonal fruits and nuts, but their mode of living was influenced by their warlike spirit or lack of it. Everywhere there was renewed emphasis on cereal raising, accelerated by the invention of the heavier ploughs, with oxen furnishing motive power for regular fields,

both German strip and Celtic field systems. Communities were tied to the plough and settled clans could and did raise more livestock. For instance, the Deverel-Rimbury people of England built rectangular corrals up to two acres in area for calving, lambing, and slaughter. Some of the meats were salted for winter use. A relatively great increase in population evidenced by their large burial grounds, occurred with greater food supply.

The Iron Age

Should we examine grossly the main streams of migrant peoples into England, for example, we would see the Aurignacians of Paleolithic period, Mesolithic Maglemosians from Denmark, Tardenoisians, Azilians, and Neolithic folk, the early Bronze Age folk, both Beaker and Wessex invaders, Urn folk, Deverel-Rimbury invaders, and many more besides. The early Iron Age, beginning in Hittite Anatolia and spreading to the Hither-Asiatics, Nilotes, and Greeks by 2000 B.C., fitted out European warriors with iron swords (Hallstatt culture, 750 B.C.). After 700 B.C. these Celtic cultures were dominant until the rise of the Gothonic (Teutonic) folk of numerous coalescing tribes and nations. The Hallstatt Celts in their great expansion conquered in England, the Continent, Rome, and Galatia in Asia Minor. In their permanent abodes they farmed, for instance in England, lonely farmsteads of perhaps 15 acres, building spacious round houses encircled by a fence compound. They pastured shorthorned cattle and pigs, raised wheat, barley, and flax, and hunted red deer and small game. Wheat (and barley) was reaped with sickles and hung on lines between posts for drying. The grain was winnowed in chalk or rock depressions, the seed crop set aside in little raised granaries for spring sowing. The food wheat was then oven dried to prevent sprouting and poured into dry, dug silos lined and covered with straw matting or skins, much like the silos of Fayum K. When these silos became too moldy or insect infested, new holes were dug and the old were used as garbage, or litter, dumps. At Woodbury nearly 400 of these pits have been unearthed. Two ox-ploughs were used for ploughing and the age-old stone hand-querns were employed in grinding grain. Porridge and flat cakes were baked.

Danish archaeologists have shown that the deterioration of climate and overcast during the Early Iron Age in Northern and Northwestern Europe forced grain cultivators to harvest their wheat-barley crops before fully ripe and resort to kilns of various types to dry grains for sweetening and storage. The lack of sunlight to ripen wheat is now known to deprive wheat and many vegetal foods of ascorbic acid (vita-

min C), riboflavin, thiamin, and carotene (related to vitamin A). Supplementation with animal and marine foods would be needed for vigor. The practice of kiln drying has long been followed in Northern and Western Europe, perhaps until a century ago. Environmental and soil factors exert profound influences on composition of food plants aside from processing, handling, and genetics. The amount of sunlight is a factor of primary importance even when compared to the importance of mineral nutrition of the plant (within the range of temperature a given plant will stand). The more sunlight time, the more ascorbic acid (and other nutrilities) are formed.

As we shall note later, these Celtic-speaking folk of many groups were in close touch with Greek commerce. Greek wine was the main article of commerce, but many lovely Greek vessels and objects of art were also exchanged in trade for slaves, furs, metals, and amber from the North. The European Celts in time developed an inspired culture which Europe had never before witnessed. This La Tène period—"the art of which may largely have owed its existence to Celtic thirst for Greek wine" as Navarro (1928) said—influenced greatly the Germanic and Scandinavian folk on the edge of the little-known world. The Celts were largely pork eaters. Their graves contained large cuts of pork, or even whole pigs were buried with richer members of their groups. The graves of the poor were supplied with a ham, a leg standing in an earthenware pot. By the time Caesar (56 B.C.) described these folk, they had acquired many of the inventions of the classic world, including the rotary quern for grinding cereal.

In Iron Age Europe the predominant peoples were Indo-European speakers. The primitive Indo-European language may not date past 8000 B.C. As Dr. Harry Hoijer (1946) states: "Since man presumably began to acquire language as soon as he began to acquire the other elements of culture and, since archaeological researchers show that culture began at least 500,000 years ago, we are justified in assuming an equivalent age for language. The changes undergone by languages since that time can obviously never be reconstructed by the comparative method. . . ." The words for horse, dog, pig, wolf, and numerous other animals are so uniformly attested in the present languages that they no doubt existed in primitive Indo-European. We may infer that primitive Indo-Europeans knew of these animals, since yoke, milk, and cow indicate domestication, as wheel and axle suggest knowledge of the wagon or cart.

Indo-European speakers predominated in central Asia, West Asiatic highlands, and India. The rapid spread of Indo-European did not

appear mysterious to most scholars until the two recent wars with Germany. For some reason, as yet incompletely understood, various branches of these linguistic stocks underwent periods of rapid expansion, during which the human beings who spread these languages migrated in many directions and disseminated their physical types as well as their speech among other peoples. There had, however, been comparable expansions before this. The Indo-European languages were, at one time, associated with a single, if composite, ethnic type and that ethnic type was an ancestral Nordic. However, we must not form the opinion that the terms Nordic and Indo-European are inseparable, C. S. Coon (1939). An Asiatic origin of Nordics, perhaps the Kurgan (Battle Axe-Corded) peoples, seems likely from Norse tradition of Asaheim, and much supporting philologic and archaeological evidence is now extant. Odin was a fair-haired Nordic god, whereas the older, preceding god Thor was rufous, like many of the Paleolithic survivors of the North and elsewhere.

The Finno-Ugrian-Magyar speakers were in the large sense Mediterraneans, but now are much mixed. Their food was protein-fat rich but they also ate some cereals. There were few Mongoloids in Europe until the Hunnish invasions in the Third Century A.D. The leading Huns were Mongols, but their hordes were generally white men, speaking Altaic tongues. Their foods were chiefly meat and mare's milk products, including the fermented koumiss, yogurt, and butter. The horse was supreme in their culture. The Scythians had cereal foods in Neolithic times. They were white men.

The Indo-European speakers of many groups from 900 B.C. on, spread the iron metallurgy culture originating in the Caucasus and Asia Minor. The Hallstatt period, the period of the Nordic Celtic expansion in central Europe, was followed by the La Tène and the late Iron Age. The Early Iron Age Irish epic "Tain Bo Cuailgne" (Cattle Raid of Cooley) which has come down to us from the mountainous northern district of Louth, Cuailgne, now Cooley, as well as numerous Irish sagas and fragments shows clearly that these folk were beef eaters, used much pork, wheat, barley, oats, dairy foods, ale and mead, leafy vegetables, roots, fish and fowl, in fact the seven basic foods. These sagas reflect great exuberance of body and mind. Long afterwards, the Scandinavian and Germanic peoples began their expansion, initiated by the Cimbrians from Jutland and Teutons against the ramparts of the Roman Empire. In European historical time the Indo-European Slavs began their "putsch" westward. There is the same basic food pattern discernible for the majority of the peoples of Europe, although there were many local

variations arising from availability, especially of fruits and vegetables. The early Italics and later Etruscans and Romans survive in present-day types. The complex movements of peoples on the horizons of Europe, Hither-Asia, and western Asia need not be dealt with here; nor do we have space for the material available for this Age and the full historical period. The available foods will be dealt with later.

As for Man, prehistoric or present, differences in culture are not in kinds—i.e., qualitative—but are quantitative. There are now, and have been, about six or seven cultural levels, Dr. C. S. Coon's classification (1948), i.e.: Level 0, subhuman society; Level 1, simple family bands; Level 2, several families, or life in the trees; Level 3, the rise of specialists and multiple institutions; Level 4, the number of institutions increasing and hierarchies beginning; Level 5, compound institutions; and Level 6, one complex political institution. Briefly, baboon colony life falls into Level 0; Desert Indians, Seal Eskimos, and Reindeer Lapps in Level 1; the Andaman Islanders in Level 2; the Sacramento Valley Indians, and Pygmies of the African forest, in Level 3; the Bedawin of the Arabian Desert in Level 4; the Vikings, Saxons, Hindus, and Aztecs in Level 5; and Imperial Rome, the British Empire, Russia, and the United States of America in Level 6.

As Dr. Carleton Coon (1948) points out, geneticists have found it is poor economics to neglect the wild strains of a species. The primitives of today may be the torch-bearers of civilization in another age. The American Anthropological Association (1947) in a statement to the Commission on Human Rights of the United Nations asserted that, "Respect for differences between cultures is validated by the scientific fact that no technique of qualitatively evaluating cultures has been discovered."

Foods in Mediterranean Lands

With the advent of iron agricultural tools, trade and migrations, plants taken to new soils, and changing climates, nutrition was bettered wherever agriculture was a reputable work. Books like "Work and Days" by the Greek Hesiod (before 700 B.C.), later the "Georgics" by the Roman Vergil, and other books taught the art of Agriculture. Many centuries before, the Sumerian-speaking folk wrote in their cuneiform on clay tablets how planting wheat should be done by plow and attached funnel-seeder, how the seeds must be sowed about four or five inches deep in the furrows, how and when to irrigate, and when to harvest, for the best grain.

The Persians introduced alfalfa to the Mediterranean countries through Greece in 490 B.C. Numerous vines, cereals, and fruits were transplanted, with beneficial results to both man and his food animals. Fig trees, cotton or "wool trees," apricots, citrons, melons, sesame, nuts, oriental fruit trees, and beets were no longer novelties. Trade supplied venerable Egypt with olive and other vegetable oils, salted fish, salted meats, cheeses, honey, melons, figs, and nuts. "Corn (wheat), oil, and wine" travelled far. Caravans and ships brought the Mediterranean world spices, silks, drugs, and ivory from the East; furs from Siberian Russia; amber from Denmark; gold and tin from Great Britain and Ireland; and silk, and nickel for copper coinage from China. The Oriental and Mediterranean civilizations, having fused to some extent in ancient culture, now joined together in commerce, and the European cultures, as Montelius pointed out long ago, were prepared for Roman civilization with its benefits and evils. The La Tène Celtic economies and diffusions to the periphery of Europe were obviously rural economies, with light ploughs and small fields of wheat, barley, and rye, together with much cattle raising, supplying beef and dairy foods like cheeses, curds and whey. Pork, mutton, fowl, eggs, fish, shellfish, apples, cherries, strawberries, nuts, wheat, barley, and rye were staple foods in season. Their cereals were carefully stored.

The Germanic folk employed deep ploughing, with iron plows, and did not merely scratch surface soils, as was the practice in Gaulic and Mediterranean lands.

Athens and the Hellenes

The Athenian of the classical period was a man of moderate diet, largely vegetarian, but mutton, pork, dog, dairy foods, and fish were widely used foods, as were eels, birds, and sausages of mixed meat-cereal composition. The well-to-do classes ate a typical dinner of fish, eels, fowl, lamb, pork, dog, wheat bread, fruits of many kinds, and vegetables dressed heavily with olive oil, vinegar, sauces, and honey. The poorer Athenian ate porridge of wheat-barley with salt or honey, barley cakes, fruits, beans, peas, lentils, cabbages, onions, figs, olives, pea soup, and was fond of sausages and black puddings when he could get them.

The protein foods consisted of pork, mutton and lamb, some beef, dogs, goats, eels, turtles, herring, sardines, tuna fish, young sharks, and many marine fish, oysters, snails, hares, wild ducks, partridges, pigeons, quail, thrushes, blackbirds, eggs, and hens. Beets, citrons, melons,

apricots, sesame, geese, buffaloes, and pickled pork were introduced into Greek commerce from the East. Mushrooms, lettuce, asparagus, cabbage, beans, radishes, varieties of leeks and onions, turnips, and lentils were eaten in quantity. Pea soup was a regular article of diet and could be bought from hucksters in the street. Walnuts and almonds came in from Mesopotamia and Persia. Xenophon said that dates were fit for slaves. There was much fancy baking of bread and rolls. The Greeks devised rotary grain mills driven by donkeys.

An aqueduct was completed in 527 B.C. which provided Athens with an excellent water supply.

The influence of coinage and small change on trade, and the resultant change in local agriculture, is typified in Athens of early Classical times. The peasants of Attica could specialize in viticulture and olive production in small gardens, and import cereals and foodstuffs in exchange for oil, wine, pottery, wargear, and ornaments. Otherwise, these folk could not have experienced their great increase in population. Their nutritional patterns bettered markedly, and the quality of their civilization should need no further word here. The Greeks sold wine to the barbarians beyond the Black Sea and as far north as Central Europe, just like the Americans sold firewater to the Indians and the New Englanders traded in rum, molasses, slaves, and opium. Diordorus states the Celts "would exchange a servant for a drink." Coined money eventually disintegrated all of the old barbarian societies. The Greeks were aware of this effect.

Sayce (1933) calls attention to the civilization of Greece, "which was not unconnected with the adequate food and leisure provided by the cultivation of grape, wheat, and olive, reinforced by foods from seaborne commerce." In the Periclean Age of Athens the commerce and manufactures of the imperialist democracy spread far and wide. In the busy city and environs and at the port of Piraeus labored citizens, resident aliens, and slaves, while farmers cultivated the olive, vine, wheat fields, and kitchen gardens. In the earliest times Odysseus boasted that he could drive a furrow as straight as any man. Many sheep and pigs were raised. The diet of these earlier people consisted of greens, vegetables, bread, wine, cheeses, and olives, and fish and pork were greatly relished. In fact, the sources tell us that fish and pork were eaten more than any other varieties of "meats."

The ordinary Athenian rose early in his simple home (with its practical but beautiful furniture), dressed in a short woolen chiton, had a small glass of wine with a morsel of bread and then, attended by a slave,

walked unhurriedly to market (Agora), or the center of town, where we are told the water-clocks and dials provided the time and barbershops provided the gossip. He might be engaged in any one of a number of trades or professions, or in politics. He usually returned home for lunch with his family, but unlike the later Romans he ate sparingly and his siesta was not long. The afternoon was spent at his work in the city and the evening spent quietly at home, unless guests were invited. In that case the men reclined on couches, reached for food on the stands placed before them, and at the end of the meal elected a head of the symposium, who decided how much water was to be added to the wine and who was to choose the topic of conversation.

Life was exuberant and the Athenian was a buoyant personality enjoying complete freedom of speech. The products of his intellectual endeavors have never been excelled. Fifth Century Athens is the first fully documented example of a government by the people. Anthropologists everywhere ask why the centers of achievement and power pass from people to people although the racial stock and geography remain fairly constant. Nutrition might furnish the answer as to rise of a people in some instances, but why were the Sumerians, Chinese, and the Egyptians a people of genius and since 500 B.C. until quite recently, had become a part of the unchanging East? Why did the Jews maintain their greatness all through recorded history? Why were the Greeks the greatest of all peoples of antiquity, but their genius so short-lived? Why did the efflorescence of Viking Normans begin so late and end so soon? Braidwood, Krogman, and Tax (1946).

It is interesting to note that the Greeks said they "must never forget the body in training the mind. We must train the whole man by gymnasia and diets." The decline of Athens, for example, after 350 B.C. was closely connected with shortages of foodstuffs. According to Rostovtzeff (1933), reduction of the export markets resulted in cessation of importation of essential foods.

Xenophon in the Persian Expedition (Fourth Century B.C.), upon his return to Asiatic Thrace, complained about the lack of olives in the villages in which he foraged for barley, wheat, vegetables of all kinds, millet, sesame, figs, grapes, and good wine. Earlier, in the escape from the Persians, he remarked about the absence of olive oil in the Mossynoici villages, whose inhabitants used only dolphin fat from their catches in the Black Sea.

In Greece man could live on much less food than in the North, but the Greek was an outdoor man and tried not to be a slave to material

things. Naturally, the pre-eminence of Greek culture cannot be attributed simply to nutrition or climate or "race," but the Greek dietary as a whole cannot be ignored. The Greek "polis" was not a city and much more than a state. We have no equivalent word. We may note that these culture areas were small. Athens, Syracuse, and Girgenti were the only cities with more than 20,000 citizens. Attica at the outbreak of the Peloponnesian War possessed 350,000 souls; a half were free Athenians, a tenth aliens, and the rest slaves. Agricultural slavery hardly existed; the citizen owned his plot of land. Attica was the territory occupied by Athenians. It comprised the "polis" Athens, Piraeus, and numerous villages. Dorian Sparta, subsisting on the labor of the Helots, was long a powerful "polis." Sparta did not fall from lack of energy but from lack of men. A Sybarite, entertained at the public mess at Sparta, exclaimed, "Now I understand why Spartans do not fear death." The frugal Spartans ate an excellent selection of the Basic Seven Foods and "all Greeks knew what was right, but only the Spartans did it." However, it is common knowledge now that Athens' contribution to Greek and European civilization was astonishing, and Athens from 480 to 380 B.C. was undoubtedly the most civilized society that has yet existed, H. D. Kitto (1951).

Many physical anthropologists find a remarkable similarity of living Greeks and the Hellenes of classical times. Ethnically the Greeks are and were a blend of the Atlanto-Mediterranean, Alpine, Dinaric, and Nordic. Perhaps blondism is not as noticeable now as in Greece of Homer's time and 800 years later. Except for one or two skulls of Mediterranean type in the Neolithic, nothing appears known until the Bronze Age of Greece.

When the ten thousand Greeks under Xenophon in the Persian Expedition reached the Black Sea, they shouted "Thalassa, thalassa," i.e., the sea, or salt-water. Thalassa is not a Greek word, H. D. Kitto (1951), of Indo-European origin, but is probably pre-Greek, picked up by the old Northern invaders when they first saw the southern seas. The Gothonic Northmen of a much later date, however, when seeing humped camels in the southern lands shouted "Ulafand!" equating the camel with the mammoth of dim tradition, known possibly to both Greek and Goth as "elephas," their food animal in post-glacial times in northern and central Europe. The later Greeks themselves believed in an original non-Hellenic people whom they called Pelasgian, remnants of which still remained in classical times, speaking their own language. We may note that grapes, figs, and olives were grown in Early Aegean (Helladic)

times in Greece. The Dorian invaders of about 1100 B.C. and the Achaeans of 1300 B.C. were a northern folk whose descent on Greece brought about a Dark Age of three centuries of chaos, after which classic Greece began to emerge with the blaze of Homer and the miraculous first flowering of civilization and art in Europe.

Greece is a region of great variety, a land of limestone mountains, narrow valleys, few rivers, and many gulfs and islands. The Boeotian plain adjacent to Attica is particularly lush with rich agriculture and plentiful food supply, so that the nimble-witted Athenian called these folk "Boeotian pigs." Boeotia, the home of Hesiod, means cow-land, one of the few areas with pastures good enough for cows. As a whole the Greek climate is agreeable and steady, with dry atmosphere and sea and land breezes in summer. It is a demonstrable fact that Greece's environment was favorable to man, not only to his longevity but also, after commerce was developed, to sustained energy. What other small area ever produced in one century men like Socrates, the most noble man who has ever lived, Sophocles, Plato, Xenophon, Aristophanes, Aeschylus, Protagoras, Isocrates, Euripides, Gorgias, and many more? These men, some of whom, like Socrates, were executed, were of venerable age at death. Life expectancy was higher in Greece than in any modern country, at least until quite recent times. H. D. Kitto (1951). Diet and regimen had much to do with this. The Greek had always been a frugal man, eating sparingly of barley, wheat, olives, and oil, wine, fish, meat, dairy foods, vegetables, and fruits of many kinds. The poorer laborer or slave might eat two courses, as Zimmern in a light vein points out, "the first a kind of porridge and the second a kind of porridge." In Homer, the heroes ate an ox every 200 verses and ate fish when destitute. The famous query, Why did the Homeric heroes never eat fish? is answered by a late Greek commentator, who without humor said, "Because a diet of fish lacks grandeur." Not so today!

The Athenian dinner was a social enjoyment without gluttony. To eat alone was "not dining, but feeding." A special abhorrence of the Athenian was "swinishness." He wanted a little of all good foods well served, and he reclined on couches during the meal. There were no knives and forks; the food was taken up in the fingers and gravies were either spooned or sopped up on bread hollowed out for the purpose. There were no napkins. Bread was used to wipe the fingers and afterwards thrown to the dogs. Wine was drunk only after eating and this phase of the dinner lasted until the Greeks were talked out, although a second course of dried and fresh fruits, salted nuts (almonds), sweetmeats, cheese, and salt was often served. Then followed the "sym-

posium," literally meaning drinking together, presided over by a guest, or host, elected "King," who decided how much wine should be drunk. An Athenian comedian says, "The first cup means health, the second pleasure, the third may produce sleep which the prudent man heeds by going home, the fourth and fifth mean truculence, the sixth disorder in the streets, the seventh black eyes, and the eighth arrest by the police." Aristophanes adds "and a headache into the bargain."

The Athenian at the Agora or elsewhere was full of talk and lively curiosity, in contrast perhaps with King Archelaus of Macedonia who, when asked by the court barber, "How shall I cut your hair?" responded grimly, "In silence."

Our modern notion that the Athenian was inordinately fond of fish may have arisen from the oft-quoted story of the philosopher-schoolmaster whose class of young men upon hearing the bell signal for the arrival from Piraeus of the morning's catch of fish, all fled abruptly, leaving one seemingly promising but partially deaf student. The master in ringing tones complimented him for his studiousness, whereupon this student dropped his roll and tablet and ran to overtake his fellows.

Xenophon, the Athenian, after receiving $\frac{1}{10}$ of the spoils won by a little brigandage at the close of the expedition of the Ten Thousand, bought an estate near Scillus (Olympia) where he listed the available foods: fish, shellfish, "all the game you can mention," barley meal, wheat, breads, wine, cheeses, sweetmeats, sheep, goats, cows, pigs, boars, gazelles, deer, olives, fruit orchards with all known fruits, and garden plots of all vegetables. Cereals were kept in the driest rooms, wine in the coolest. "You must be careful not to eat too much." Socrates admired this way of life. "A rich man can eat no more than a poor man." As to manufacturers (owners), foremen, and overseers, Socrates remarks when they are accused of idleness, "Ah, tell them the story of the sheep who complained that the watch-dog did nothing."

Xenophon mentions leavened bread. The bread and cakes were inspected for weight and contents by market police. Olive trees were the "cows" of classical times, and if ravaged by wars left the area in dire straits.

Sauces of many kinds were devised for fish, meat, and game. Seasoning was done with vinegar, wine, salt, mustard, garlic, onions, pennyroyal, and marjoram. There was no pepper. Honey was employed as a sugaring agent. Olive oil was used for fish, flesh, and greens alike. Milk was not drunk, except in rural districts where goats and sheep were milked (cows were seldom milked). Water was drunk only by mixing in wine, but only the Thessalians were intemperate.

Upon arising at dawn, breakfast was eaten and usually consisted of barley cakes, bread or rolls, dipped in dilute wine. A little before noon the Athenian ate some fresh or salted fish, ham, and sausage. At sunset the dinner, or heavy meal, was eaten and consisted of numerous foods within the Basic Seven classification.

Some of the Greek philosophers were like our supposedly absent-minded professors. Thales, walking along looking up into the heavens, fell into a well. Aristotle tells us Thales was accused of wasting his time on idle pursuits, but Thales straightway noticed by certain signs that the next olive crop would be bumper, and bought options on all olive and wine presses of Lesbos. When the large crop came in and everyone needed presses at once, they had to meet Thales' prices. Demosthenes, speaking of bankers and commercial people, wrote, "In the world of these men it is thought quite remarkable if a man is both clever and honest."

In Xenophon's *Table Talk* one of the guests explains that Homer says somewhere that an onion goes well with wine. "Ah!" says another guest, "Niceratus wants to go home smelling of onions and garlic so that his wife will think no one else has so much as thought of kissing him!"

Pythagoras, according to legend pursued by his enemies, lay down at the edge of a bean field and allowed himself to be overtaken and killed rather than contaminate himself with the legume which he despised and which he proscribed for his followers, C. Malmberg (1935).

Athens received wheat and grain from Sicily, Egypt, Cyprus, Euboea, and southern Russia. Wine and oil were usually produced locally. Dried fish were imported from the Bosphorus. Greens were produced locally, as well as breads, cheeses, and olives. Pork and fish were the staple "meats" of Athens. A great deal of honey was consumed. From Bithynia large quantities of cheese were imported; from Pontus, fruits; and the nuts of Babylonia, prunes of Damascus, and raisins of Bertytus were all prized but important products in the international markets of 400 B.C. All useful articles of the known and little known world might be found at Piraeus, the port of Athens. By the middle of the Fifth Century B. C., Piraeus was the busiest port in the world. Later, during the Hellenistic Age, regular port depots for the international grain trade were established at Rhodes and Delos (to 161 B.C.).

Colonists from Charcis were the first to go to the Italic Peninsula (750 B.C.), and they founded a colony at Naples and Cumae. The Graii who had accompanied the Chalcidians traded with the Romans who then called all Hellenes Graii or "Greeks," whereas, the Greek colonists in Sicily derived the word Italia from the Oscan's land across

the strait, Vitelliu (calf-land). The Greeks knew themselves only as Hellenes, like the Cymri and others whom the Gothonics called Welsh and Walloons, and the Asiatic Moscovites who in 1000 A.D. called all western blond and rufous Nordics "Russians!"

All agriculture, from plowing, sowing, reaping, grinding, and baking, came under the aegis of the Demeter cult. Every Greek who took part in these services was a religious apprentice to Mother Earth. The cult was extensive and much later Cicero wrote that the whole of Sicily belonged to the bread goddess, Demeter.

S. Casson (Antiquity 1938, 466) found that the islanders and coast dwellers of the Aegean still live on the same food and in similar houses to those of their ancestors. Their economic conditions and food differ little in simplicity from the Bronze Age.

Babylonia and Palestine

Babylonian culture based on the Sumerian was a way of life built slowly through the centuries. Agriculture provided the chief means of livelihood. The land was held largely by the kings, temples, and nobles, but tenants and small freeholders were required to keep canals in order for irrigation and transport. Magazines within temple precincts contained an immense variety of produce: wheat, barley, sesame seed for oil pressing, onions, numerous vegetables, dates, beer and wine, dried and salted fish, fat, wool, hides and skins. Barley was the main crop but emmer was plentiful. Fish was the main protein food, but sheep, pigs, and cattle were kept. Fish were kept in fish ponds but were also taken from the rivers, canals, coasts, and open sea. Pigs were kept in swamps and then fattened on barley and refuse in sties. Their woods were date groves and between the palm trees were cultivated grapes, figs, pomegranates, apples, and mulberries, H. Frankfort (1951). On the farms were grown date palms, the many vegetables, and wheat and barley. The domesticated animals were cattle, oxen for transport, pigs, sheep, goats, and donkeys. The horse and camel were latecomers. Herodotus (Bk. 1) describes Babylonia, like Egypt of 450 B.C., as intersected with canals, and stated there was no country so fruitful in grain. The olive, fig, and vine were not much grown, but millet, sesame for oil, palm trees (which furnished fruit, bread, wine, honey, and wood) were staple crops. Fish were eaten fresh, and fish dried in the sun were ground in mortars for cakes and a kind of bread. Grain was cut with sickles of burnt clay.

The ancient myth, "The Wooing of Inanna," tells how the farmer and the shepherd sued for the hand of the Goddess Inanna. Her brother is in favor of the shepherd whose "butter, milk, small cheese, cottage

cheese, honey are good—all the shepherd's products—wool, tufted cloth—are splendid," but Inanna wants the farmer "who can grow grain (wheat, barley), can grow beans, make prime beer, bread, and numerous other foods of field, garden, and orchard." The people of the Mesopotamian city-state around the Third Millennium B.C. were mostly sharecroppers, serfs, or temple servants. Man had been created to relieve the gods of toil. The dictum of society was that a peasant without a bailiff was like a field without a plough. There were, however, periods of upheaval as in Egypt following the great pyramid era, and in Palestine, when the poor became rich and the processes went on as usual.

The Babylonians, according to the Book of Oannes, regulated slaughter of food animals and controlled the sale of meats. They did not eat beef or pork but, like the Greeks and Amerinds, were inordinately fond of young, fat dogs. A list of protein and plant foods and herbs given by Jensen (1949), which were utilized in earliest times in the Valley, consisted of fish, sheep, dogs, dairy foods, wheat, barley, lucerne, dates, figs, grapes, apples, mulberries, Persian peaches, eggplant, melons, cucumbers, turnips, radishes, beans, garlic, onions, leeks, sesame, vegetable oils, mint, cardamons, pennyroyal, dill, saffron, coriander, thyme, mangold, lettuce, and beer and wine.

When Abraham migrated (about 2000 B.C.) from Mesopotamia [Ur of the Chaldees which Sir Leonard Wooley (1950) and others excavated, and through which they restored for us the everyday life of the city of Abraham], he and his people had adopted and borrowed many food practices of the Valley. Today the Euphrates runs 10 miles east of the ruins of Ur and the great plain is a barren desert. It is not known when the river changed its course.

The ancient Jewish food practices, so remarkable when viewed with microbiological and nutritional knowledge of today, need intensive study of the source material, like the studies of S. I. Levin and E. A. Boyden (1940), also H. E. Jacobs (1945). Their basic foods were much like the foods elsewhere in the Fertile Crescent, but their preparations and choice of foods were rigidly controlled through keen observation and retention of experience. Wheat and barley groats were cooked with cut-up tender lamb or morsels of mutton, together with many kinds of vegetables: beans, lentils, peas, onions, leeks, garlic; and the foods listed above. Olives and oil, grapes and raisins, honey and dates (taking the place of sugar), almonds, walnuts, apples, pears, pomegranates, and figs were staples. In the Sixth Century B.C., fowl and eggs (chickens, ducks, geese) became important items of diet. Beef, selected and trimmed according to code, was used extensively.

In the book of Leviticus, Chapter 11, and Deuteronomy, Chapter 14, the Code of Moses given to the Israelites lists the animals, fish, birds, and insects than can be eaten and under what conditions they can be eaten. It is forbidden to eat the meat of the pig, camel, and horse, and the shrimp, lobster, oyster, and crab. Meat must be produced according to code and must meet health standards. Because of pagan pre-Biblical customs meat foods and dairy foods could not be eaten together. Animals of the chase were usually forbidden. The great physician-philosopher, Maimonides, long ago pointed out that the Kosher Code restrictions were health measures, particularly in case of pork which may be parasitized and spoils rapidly in warm climates. He pointed out also that there are moral values to be gained from restraint in eating habits, and discrimination in satiety reflects on self-control with other of life's temptations.

Qualified students, both historians with a pragmatic bias and theologians as well, might glean something useful from the science of nutrition when they attempt to explain the cause of the extraordinary influence of Palestine on world history. Israel never adopted foreign practices and ideas until they proved their worth and could be assimilated without sacrificing autonomy of spirit, W. F. Albright (1949). Until the nutritional patterns of the Jews from Ibrahim Khalil Abdurrahman, the friend of God, down to recent times is revealed by patient research, we may anticipate much of interest.

Rome

A great many works on general agriculture, botany, livestock farming, weather, milling (rotary mills), baking, preserving, and foods generally were at the disposal of the gentleman farmer of the classic world.

Except in rock quarries and mines where slaves were worked to death, some slaves of the Roman world lived on a better diet than barbarians of the peripheries. A two-story baker's house at Pompeii contains four donkey mills and many ovens.

One thing stands out rather clearly regarding civilized Mediterranean man and his food, when he emerges into the historical period and becomes settled in one place. He is largely a vegetarian. Meat is usually not for him, because of price. History hints that he would like to eat meat. The vegetarian diet early came to be despised by the upper classes in populous districts in Mediterranean lands. It would appear that man has never been a vegetarian by choice, but thousands of years of vegetarianism in Mediterranean communities and elsewhere have left their impress. The racial theorists who postulated that Mediterranean peoples

naturally desired cereals, vegetables, and olive oil forgot that these good folk, settled in the United States or Canada, became beef and pork eaters like their fellow citizens of the North. We witnessed the black market frenzy during World War II, and observed the universal clamor for meat by beef eaters and vegetarians alike. However, during World War I, Professor Rubner, the great German physiologist and dietitian, observed that no commercial article is so much in demand as one which is scarce.

In ancient Rome about the time of Cicero, the mass of the population lived in large lodging-houses called islands, or *insulae*. These tenement houses had streets on all sides of them and were built about four to six stories high. The ground floor was occupied by commercial stores and shops. The cellars were used for storage of foods and some baking was done there. The top floors were very insanitary because of lack of water pressure from the aqueducts. Wealthy Romans like Cicero invested large sums in these "rabbit warrens," and lamented bitterly when fires or demolition from faulty construction depleted their wealth. In villages and some sections of cities of Roman times open markets grew, until today we have fundamentally the same types of city plans, apartment buildings, basement stores, business streets, both large and small, milling districts, meat plants, and manufacturing districts.

Rome and her commercial cities imported every known food and food habits changed greatly in the upper strata of society. The mass of people, however, were bread eaters and wine drinkers, although on certain days flesh was eaten if it could be had, i.e., carnival (*carnis,* flesh; *vale,* to remove; meaning farewell to meat). This was especially true in Christian times. Polygot Roman cities also learned new food habits both by mixed marriages and diffusion. The Roman kitchen and the occidental kitchen of 70 years ago were much alike, the great changes coming about some 50 years ago in urban American homes.

The first thing to note in viewing daily life in Rome was that the Romans, like the Greeks, were busy much earlier in the morning than we are. Lighting for houses, and street lights, were poor or nonexistent; the wick was unknown, and private houses were lighted with torches and rude tallow candles. Because artificial light was poor and the uneducated man feared the dark, legitimate business stopped abruptly with the setting sun. Soap was not known until the first century of the Roman Empire. The cultivation of the olive tree in the last century B.C. led to the universal use of oil lamps in huge numbers. Pliny states that olive oil was first exported from Italy in 52 B.C. The Roman night was, however, quite dark. Cicero on the fifth of December, 63 B.C., returning home

from the execution of the conspirators, was lighted by people placing lamps and torches at their doors and "women showing lights from the roofs of the houses." Cicero, Horace, Pliny the Elder, and Emperor Vespasian all were early risers and at sunrise in Rome the whole population was astir; boys on their way to school and workmen to their labor. Horace says that the lawyer met his clients at cock-crow; otherwise, if he had no clients, he would purposely walk to the Forum to give prospective clients their chance. Cicero makes it plain that this was not his way. The breakfast at dawn was usually meager, and Antiochus, the great physician, according to Claudius Galen (130-200 A.D.), visited his patients on foot before breakfast. Antiochus' breakfast consisted of bread and honey. All of the vocal professions would then proceed to the Forum and spend the day from morning to night trying to best their fellows. The law courts, which had become the places for scenes of oratorical display and indulgence in personal abuse, attracted great crowds of idle people who were fond of excitement. Thus the dinner hour (noon) came to be postponed until evening or before, and a "snack" was eaten at noon. If a man was at home, he might take a siesta (in the summertime), but busy men like Cicero said they could not afford the time.

While the Earl of Sandwich is credited with "inventing" the modern sandwich, the Romans ate sandwiches of all kinds and called sandwiches *offula*. At each period the sandwich and "snacks" altered eating habits and nutrition generally. The heavy meal would then be the evening meal, or supper, now called dinner. Dinner, as everyone knows, was formerly the heavy noon meal of active folk who needed energy. All through classical and medieval times a light breakfast was eaten at dawn and consisted of bread, porridge, or sour milk, and a beverage of the country; the heavy dinner was eaten between nine and 10 a. m.; and supper at sunset. The routine as stated in Roman, Old French, and Old English texts is translated:

Rise at five, dine at nine
Sup at five, to bed at nine
Is the way to live 90 and nine.

The poorer Italians, like the poorer Greeks, were then, as now, almost entirely vegetarians. Cattle and sheep were used for production of cheese, wool, and leather, or for sacrifice to the gods. The only animal commonly eaten, until luxury came in with increasing wealth, was the pig, and grain and vegetables were the usual foods of the farmer and the city dweller.

In one of Vergil's poems, the Moretum, is given the picture of the food supply of the small farmer. He eats hot-cross buns made of coarse grains, and also a hotchpotch made of herbs and vegetables. The farmer had no sides of smoked salt bacon hanging from his roof; only a cheese. The absence of cured pork ("durati sale terga suis," line 57) is interesting. Some writers state that no doubt the Roman took meat when he could get it; but to have to subsist on it, even for a short time, was painful to him. More than once Caesar, in his Gallic campaigns, remarks on the endurance of his soldiers in submitting to eat meat when wheat was not to be had. It is possible that meat prepared for Caesar's active legions was often tainted or frankly putrid by the time it could be distributed to the units engaged in warfare. Before mechanical refrigeration and veterinary inspection, this was long the fate of fresh meat on European battlefields and in camps.

The Romans had meatshops resembling closely the shops (scales, rails, and tools) of today, especially in Europe, and they were conducted in a sanitary fashion. The Roman market police controlled the sale of meats, exacted fines, and directed that meat and botuli (sausage) which they had condemned should be thrown into the Tiber. The ancient Roman butchers and meat chefs prepared and used cracklings, bacon, tenderloins, oxtails, pigs' feet, salt pork bellies, fig-fed hogs, all kinds of steaks, chops, roasts, boiled and stewed meats, loins, kidneys, shoulders, livers, and lungs, sausage of many varieties, and meatballs. They knew the technique of boning beef, lamb, veal, and pigs, and dealt in wholesale and retail cuts much like those of today.

The little known M. Gabius Apicius, who is believed to have lived during the reigns of Augustus and Tiberius (80 B.C. to 40 A.D.), excelled in preparing vegetable dishes, but his book contains such captions and formulae as follows:

10. "To keep meats fresh without salt for any length of time." (Honey as preservative.)
11. "To keep cooked sides of pork or beef or tenderloins." (Used a pickle of mustard, vinegar, salt, and honey—a method still in use in France and Central Europe.)
44. "Liver sausage." (Formula resembled modern processing; smoked in casing as it is today.)
60. "Little sausages" or botellum (smoked).
61. Lucanian sausage (a smoked, mixed meat product).
63. Pork sausage in links.
65. "Round sausage." (Chopped pork, bacon, garlic, onions or leeks, and pepper. Smoked until all the meat under the casing takes on a pink color.)

Apicius, who lived in Campania, was a very rich gourmet and spent fortunes for his table, eating seafoods and inventing "cheesecakes." Most of our ready-made meat sauces, condiments, and spicing fluids like Worcestershire and mustard date back to him. He imported luxuries like cherries from Pontus, oysters from Britain, and sausage from Greece. He kept certain fresh vegetables green by boiling them in copper kettles with natron or soda. We now know that traces of copper increase the pigmentation of chlorophyll, the green pigment of plants. Apicius sweetened salt meat or fish by boiling in milk prior to boiling in water or frying, and used a sour dressing of vinegar to keep perishable foods safe from the hazard of food poisoning, just as army cooks do today. When Apicius' fortune shrank to a paltry quarter of a million dollars, he committed suicide by poison so that, according to Seneca, he need not fear starvation!

In Rome the butchers, bakers, tailors, and other craftsmen formed guilds for their protection. The Consul Terentius Varro who commanded at Cannae, was, in his youth, a butcher, and Cicero and Livy, typical Roman gentlemen, cried out against Varro because of his origin. Following the wars with Hannibal and the conquest of Carthage, the consumption of meat became general with the growth of capital. Among the upper classes a vegetarian diet came to be despised. In the Pseudolus, the chef of a great Roman household prides himself on "not being as other cooks are, who make the guests into beasts of the field, stuffing them with all kinds of food which cattle eat, and even with things which cattle would refuse!"

The chefs were so powerful in certain reigns that the Roman market police, if they tried to enforce the law, were turned over by the patrician to his chef and cooks for rough handling. On the walls of taverns and hotels guests scribbled their opinions of the proprietors. These scribblings can be seen in Pompeii today. The walls of shops and eating and drinking establishments were also plastered with advertisements rivaling the ads of their descendants. Plautus tells us that some of the cooks were so slippery physically that one was called *"congrio,"* or eel, and another *"anthrax,"* or coal. Practically all types of the cooking utensils of the Romans are in use today.

Diocletian's Edict of Prices (301 A.D.)

Diocletian, an Illyrian officer who became master of the Roman Empire, favored despotic socialism and ardently tried to lower the cost of living by setting a maximum price on all manufactured goods, clothing, and food, as well as on every form of labor. Even though death was

the penalty for infraction the edict failed, because it drew no distinction between wholesale and retail prices, failed to differentiate quality of goods, and obviously, the variations of supply and demand. Later, Julian attempted to fix ceilings on food prices. In both attempts foods were bought by speculators and hoarded, so that poor people starved. In the end, the Roman rulers had to acknowledge their inability to cope with an economic law. Diocletian's list of maximum prices, given by Momsen, and equated with 1906 (Bureau of Labor Bulletin 77) and 1946 prices, is of interest:

	Diocletian	1906	1946
Wheat, bu.	$0.33.6	$1.19	2.00
Rye, bu.	.45	.79	2.68
Beans, bu.	.45	3.20	4.25
Barley, bu.	.74.5	.55	1.28
Fresh pork, lb.	.07.3	.16	.55
Fresh beef, lb.	.04.9	.18	.65
Fresh mutton, lb.	.04.9	.16	.50
Ham, lb.	.12	.18-.25	.80
Butter, lb.	.09.8	.26-.32	.85
Fresh fish, lb.	.07.3	.15	?
Cheese, lb.	.07.3	.20	.50
Eggs, doz.	.05.1	.25-.30	.65
Cow milk, qt.	.06	.06-.08	.20

In "An Exposition of the World and of Nations," translated from Greek into Latin about 385 A.D., we have a picture of trade in the Roman Empire. Illyria supplied bacon and cheese, and Spain was extolled for its bacon and oil; but North Africa furnished most of the oil, Numidia raised most of the cattle. Some 45 years before the now famous Edict of Diocletian, which attempted to establish ceiling prices in the Empire, Lactantius *(de mortibus persecutorum, 7)* recorded that blood flowed and that it was impossible to enforce cheapness by the hands of executioners. It was finally recognized that after attempts to terrorize businessmen into submission, the edicts were fruitless. "Prices not only arose eight times the ordinary value but to an extent that could not be expressed in words." Bacon, when it could be had, sold for more than 16 times the ordinary price. Julian also made a similar and unsuccessful attempt to regulate fair trade. "Caesar madness," causing rulers to affirm their will and wisdom against economic laws, had never been successful.

Trades and crafts were then "encouraged" by the Emperors and henceforth carried on not as free professions but as compulsory services. Corporations were required to hold their workers to their jobs all

through life. Fugitive butchers or bakers, or concealers or protectors of fugitives, were severely punished by law (Arcadius and Honorius decree, 395 A.D.).

The collegia, or guilds, of bakers and purveyors of pork engaged in supplying the capitols with food and transport, suffered greatly, according to a curious letter of St. Augustine's. The bishop had been approached by a certain Bonifacius who dealt in food and transport and who wanted to pass over his property to the Church. St. Augustine (354-430) refused to accept the gift because, he states, in case of shipwreck the Government would order an inquiry, the sailors rescued from the wreck would be put to torture, and the Church would have to pay for the lost cargo.

The Roman Empire could easily have "fallen" from the restriction of free enterprise, with resultant impairment of food supply.

A dinner menu of Martial and Juvenal (100 A.D.) shows us the well-to-do Roman's food "from eggs to apples," or "from soup to nuts," as some Americans say. The dinner began with eggs and asparagus and then came many dishes, among which were kid and chicken, sausages, bacon and beans, cauliflower, cereal, lettuce, onions, fish with sliced boiled eggs, olives, toasted peas, green beans, chestnuts, fruit cocktails, peaches called Persian apples, apricots, pears, and apples. The Roman chefs learned to prepare rice dishes, formerly a rare food prescribed only for the sick. Horace in a light vein describes the dismay of a Roman miser when he learned the price of a bowl of rice prescribed by his physicians. Salt shakers were within handy reach and the diner used spoons and knives of various sizes. Fingers were used instead of forks.

Says a character who resisted change, in one of the comedy fragments of Cicero's time:

> "May the Gods destroy the man that first discovered hours, yes and the man that first set up the sundial here, and took the day apart and smashed it for miserable me into little pieces. In the old days when I was a boy, a man's stomach was his sundial and by a long way the best and truest of all your time pieces; at any time you felt that way it told you to eat, except when there was nothing. Now, when there is something, you don't eat unless the sun agrees to it. Yes sir, Rome these days is filled full of sundials, and most of the people in it are dragging around dried up with hunger."

Bread, wine, and oil were staples in Rome as in other countries in ancient times. The first public bakery of Rome was established in 171 B.C., after which homemade bread went gradually out of use in cities, although slaves on rural estates prepared it. The Roman bakers were organized into a college, or guild, under a president. Vast estab-

lishments of both mills and bakeries and also transport were built by the government and let out to the guild. Emperor Trajan gave suffrage to every miller who worked for three years in a grain mill of 100-modii capacity of wheat per day. At the time of the Gracchi (130 B.C.), there had been a monthly distribution of wheat among the people. Four hundred years later Emperor Aurelian distributed bread free, together with free tickets to the circus *(panem et circenses)* and the Roman common man found his needs of body and mind.

Different qualities of bread were baked at the great Roman public bakeries. The best was from fine wheat flour and a second-grade loaf was made from good white wheat flour. Second-quality flour for soldiers' coarse bread was made from Wheat Flour No. 2, mixed with bran and millet.

There were huge public magazines for bread storage, also small bakeshops where cake, cookies, pastry, and confectionery or *dolci* (sweets) were made and sold by private enterprise. The bakers used honey, but preferred syrup of sugar cane imported from India. The syrup was called "sakari" *(saccharum)*, the earliest mention of sugar in western history. These "tuck" shops were besieged by schoolboys in the early morning hours. The poorer boys bought plain quartered hot-cross buns, of which specimens have been found at Pompeii.

The mills were hand mills, mule-turned mills, and water mills (water mills coming in the fourth century of our era). General Belisarius, during the siege of Rome by the Goths in 536 A.D., devised a floating mill whose wheels were turned by the Tiber current.

Bacon was used largely to flavor porridge and coarse bread. The countrymen drank milk and unfermented must and wine. All ate beans, peas, lentils, cabbages, beets, turnips, radishes, carrots, asparagus, artichokes, chicory, onions, leeks, garlic, parsley, melons and cucumbers, lettuce, mallow, cress, mustard, anise, fennel, mint, and black pepper. Beans and onions were raised extensively, but the Greek Pythagoras forbade his disciples to eat beans, a food, he said, fit only for blacksmiths, gladiators, and farm-hands. Varro asserted that their Roman forebears were at their best when their talk "smelt of onions and garlic." Horace wrote extensively against the use of garlic, and Naevius reproached the gods for not having confounded the gardener who first grew an onion. The finest of all vegetables, according to the elder Cato, was cabbage, which seems quite consistent with what we know of Cato's character. Cato, the farmer-statesman, taught the old Roman virtues by example, but this red-haired, grey-eyed, unsmiling old republican was hated by the nobles, who were touchy about their follies and sins. Cato's

"On Agriculture" is the earliest book in Latin prose which has come down to us. He gives detailed instructions and advice concerning the growing of vineyards, olive orchards, wheat and barley, and all sorts of vegetables, and also successful livestock farming. A similar book with the same title by the Carthaginian, Mago, was later translated into Latin and was, fatefully enough, a better book than Cato's.

Butchers' shops abounded in Rome of 140 A.D., where even poor people bought goat's flesh. Beef was not much eaten but pork was always popular in forms of bacon and sausages.

Because of lack of refrigeration, poultry was easier (than beef or pork) to dispense, and chickens, ducks, geese, peacocks, cranes, grouse, partridges, and pigeons were much eaten. Hares, rabbits, and deer were cheap meats and the price of wild boar meat was within everybody's reach. Fish were in great demand salted, pickled, and fresh, and were either brought into Rome by fast-moving wagons from Ostia or the near-by seacoast, or alive in water tanks. Some of the villas or manors kept fish pools for carp, mullet, turbot, and eels.

Thermopolia, or hot drink food-stands, were plentiful and popular, where hot spiced wine, sandwiches, pea soup, and bread were eaten by laborers. Country taverns and inns were, according to our literary sources, places of evil reputation, full of robbers and vermin.

Aurelius Victor says that under Augustus, at the beginning of the Imperial period, about 48,115,000 bushels of grains (our standard) were imported from Egypt and Africa. This supply lasted only four months; 144,345,000 bushels were required for one year and for a population under two million. This was all handled by the Guild and stored until ready for use in the Imperial warehouses, called *Horrea Galbana* from the family of Sulpicius Galba who sold the property to the government and who were rich "warehousemen." These warehouses were first excavated in our time by Professor Lanciani.

It is believed that commerce developed before adulteration of merchandise. Pliny (XVIII, 29) tells of frauds practiced by Roman bakers. They added to the bread a white earth, soft to the touch and of a sweetish taste, obtained from a white earth hill called "Leucogee," situated between Pozzuoli and Naples. Pliny found the adulteration of wine a fine art in Rome. Greek history also records many bad food practices, so that special inspectors were appointed whose duty it was to stop adulteration. A Greek, one *Canthare,* excelled in adulteration of wines and foods and knew how to mature new wines rapidly. His skill was so great that the simile "artificial as Canthare" was handed down through the centuries.

After the decline of Rome the Gothonic nations retained many meat processes taught to them and developed by them during their migrations by land and sea. Many of the old Roman cities in Germany and the Latin-Romance countries still held on to their guilds of butchers, bakers, leather craftsmen, as well as guilds of other crafts.

The folk of the Roman Empire received much useful technological information and products from the central and northern European barbarians. Chief among these were the wearing of trousers and fur coats, the compact house which could be heated, felt making, soap, butter to replace olive oil, and above all, the cultivation of rye, oats, new wheats and hops, the art of cooperage of wooden barrels and tubs, the stirrup, and the heavy iron plow, C. A. Robinson (1951).

Roman trade was truly a world trade from Norway, Denmark, and Scotland, to China, India, and the Near East, Arabia, and Africa. The standard of living of the masses was obviously lower than the favored groups, but their diets had for centuries been wheat bread, olives, figs, cheese, and a little wine, poultry, fish, and meat.

With the failure of the great cities and their trade after 250 A.D. in the then world-wide dependence for goods, both city dweller and countryman grew poorer until they resumed the self-sufficiency of the Bronze Age folk. The common folk, uprooted from their small farms in later Classical times and herded together in large cities, did not live in opulence. Their needs were few and their foods were mainly wheat bread, olives and oil, figs, some meat on rare occasions, and wine. Many biologists explain the decline in fecundity, which became notorious in all classes of the later Roman Empire, as due to lack of proper foods and the failure of Roman economy. It is now known that fecundity is a matter of other stimuli as in the Orient where malnourishment is rife. When the Germanic or Gothonic war bands came into the classic world they precipitated the Dark Ages only in the breakup of political unity. The Roman villas and their fields and meadows gradually transformed into the manors of Medieval Europe—the -ville names of France, -weiler of Germany, and -thorpe and -by of the North. These subsistence agricultural holdings became the familiar holdings of the feudal lords with their serfs, artisans, and cultivators.

The ordinary livestock of a villa included horses, cattle, sheep, and pigs. Chickens, geese, ducks, and pigeons were often kept, and dogs and cats were needed. The foods were bread, meats, milk, cheese, wine or beer, eggs, salt, condiments and savoring agents of the region, fish and some game: deer, wild boar, hares, and wild fowl. Beef cattle and sheep were often killed, cut up, and cooked on the spot, thus supply-

ing ascorbic acid also, which disappears upon storage of meats. Some vegetables, fruits, and nuts were eaten in season, but were inadequate in amount, variety, and regularity of supply.

New sources of food and greater amounts of food stimulated growth of Danish populations until lack of territory, together with a number of cold and flood years, sent the warlike Cimbrians of Denmark south to find new homes (101 B.C.), the first of the Gothonic invaders.

Europe did not return to the Stone Age of hill-fort, but rather to the form, at least, of the old temple cities of the Tigris-Euphrates, with their cathedral, abbey, or cloister as a Christian center. Wordsworth wrote, "Around those churches gathered towns safe from feudal castle's haughty frowns. . . . " The warrior nobles built wooden palisaded (phalburg, faubourg) strongholds; later their incastellations were built of stones and bones of the oppressed. Local famines were always imminent, since the grand commerce of Rome was no more. We now begin to see appalling deficiency diseases which kept Medieval Europe depleted, morose, religious, and not often in buoyant health except in favored regions of the Low Countries, Switzerland, Norway, Western Normandy, and Yorkshire, where the stout peasantry was not continuously oppressed.

Part III

FOODS, ENVIRONMENT, AND MAN'S NUTRITION

* * *

CHAPTER XI

Social Aspects of Nutrition

Sacralization of Food

The sacralization of food, a source of human emotions and social ties, secondary values which foods acquire in Cultural Levels One to Six, C. S. Coon, (1948), decreases with scientific knowledge, but has not disappeared in our time in the highest level (p. 127). We have not the space here to discuss the numerous taboos, sacrifice rituals, totemisms, and the fate of the "low man on the totem pole" or other phases of sociology influenced by foods.

Audrey Richards (1948), in her studies on hunger and work in a savage tribe, observed that nutrition as a biological process, i.e., sociological process, is more fundamental than sex. Professor Malinowski, in the preface to Dr. Richards' book, agreed wholeheartedly that this is the case in both primitive and highly developed cultures. The overemphasis on sex (and neglect of other appetites, drives, and interests) has in previous studies obscured the issue. Furthermore, according to Professor Malinowski, commonsense tells us that nutrition is an independent impulse. The drives of hunger and appetite, and the bonds of cooperative economic interests and commensualism, both in Paleolithic and Neolithic times, stem from nutrition in the sense of biochemistry and sociology. Dr. Richards finds, as biochemistry has long taught, that nutrition in a primitive tribe is a single process, from suckling, or lactation, and family life continuing through the period of full economic

status of the adult. Obviously, there is nothing more important to man than what foods he eats and how he eats. As Armitage (1922) points out, man is distinguished by the extremely wide range of food he can eat, and anatomically he has developed the incisors of a rodent, the molars of a plant eater, and the canines of a carnivore. Few animals have had such a power of adaptation and such a large number of tastes or appetites. His diet has been limited at certain periods according to some writers, but from lower Paleolithic times to the present some of the many forms of man have managed, when not limited by regulations of taboo, totem, etc. of their cultures, to find good sources of essential nutrilites. For instance, food gatherers limited usually by quantity of food did eat highly nutritive foods in the forms of grubs, slugs, insects, etc., which we in our culture condemn in disgust. We can always fall back on the ancient proverbial *de gustibus non est disputandum.* "There is no accounting for tastes."

Wherever man's diet was limited we suspect that cultural restrictions were in force. How far we can apply the observations made on living primal man to the man of the Pleistocene is controversial, because of complex culture changes in primitive cultures observed in historic time, including the present. Memory, which distinguishes man from the apes and other animals, has usually aided man in his nutrition and security of supply, but in evolution of his conscious faculties, he, in his fears and anxieties, has often injured himself by his rites. His nutritional memory is nowhere so important as in the numerous instances where he differentiated poisonous from edible plants; discovered methods of detoxifying foods like manioc, chestnuts, certain seafoods; and above all, found the empirical sanitary effects of cooking.

Social Aspects

The importance of nutrition as a social activity is well attested by both ancient and modern thinkers, and present-day biochemical data, so great in detail and so rapid in advance, extend the overwhelming importance of proper diets on man, the individual, and his cultures. Lord Boyd-Orr and many others point out that malnutrition of the East and opulence of the West must lead to conflict if not corrected in time. Hidden hunger from faulty dietary practices leads to psychosomatic impairment.

Anthropologists see clearly the series of economic stages based on food—hunting, collecting, or gathering; food production in lower and higher agriculture, pastoral, garden and field crops; industrial—each stage determining the general course of social institutions.

E. Evans-Pritchard (1940) in his study of modern primitives observed the Nuer in their environment and culture to have reached a state of equilibrium and stability. As long as present relations exist, cattle husbandry, horticulture, and fishing are carried on but cannot be improved. They hold their own but do not advance. Their culture is a part of a mature eco-system, itself the result of an interaction between the biome (complex of plants, animals, man) and habitat (soil, environment). There is no room for improvement and there is little doubt that this is the normal condition for primitive society. The changing temperatures and rainfall of prehistoric Europe and Asia in post-glacial times must have altered this pattern of stability drastically and suddenly. Primitive farming economies, for instance, never expanded northwards beyond the range of deciduous forests.

In primal societies the whole culture is held together by nutritional adhesives. The "Nutritional System," as Dr. Richards calls the structure, provides the fundamental concept for future research of the social anthropologist and others as well, if we are to understand man in his complexities.

A voluminous literature might be written on the necessity of providing an optimal diet for all men, citing primal man first, in his reactions to food shortage and kinship ties. Certainly, we have evolved enough to forsake Pleistocene practices. The proverbial hunger of small boys of all races and stages of cultures may in primal times have sharpened their wits and conditioned them for adult life, but we now know proper nutrition in childhood is of overwhelming importance psychosomatically. Furthermore, in both food-gathering and food-producing times youth developed his first fears through insecurity, although older boys after initiation rites usually became tyrannical to the children. The adults ate while the children and dogs looked on, eagerly awaiting the scraps. At the present time the maladjustments may appear in overeating. Success in primal cultures is largely conceived in nutritional terms, Richards (1948).

Esthetic Considerations and Taboos

The rapidly advancing science of organoleptic qualities of foods, (Crocker, Renner, Gelman, and Dove), has sharply delineated *food acceptance* and food selection and preparation. Primal man has a range of taste in preparation of a monotonous (to us) food that has often been commented on in surprise by ethnologists. Again the changing foods, with changing seasons and availability of food in a food-gathering culture, lead to profound changes in the whole feeling-tone of the commun-

ity, Richards (1948). Gluttony and fasting beyond his control; colic from distention of the belly and gastrointestinal irritation from nutritional depletion were his lot until the Neolithic Revolution. Certainly, man still suffers in this way, but obviously he need not.

Primal man enjoyed the pleasures of eating without knowledge of function of nutrition, just as he enjoyed sexual pleasure without being aware of the nature of paternity. Sharing of food and drink between man and woman universally defines the "legal" relationship between the two. The offering of cooked food and sometimes ale (bride-ale of the Vikings, hence "bridal") figures largely in early-day marital ties. The cohesive ties of family, clan, and tribe are dependent on the food quest.

In our day scientists and laymen alike may associate food poisoning with putrefaction. Dr. G. M. Dack (1949) observes that putrefaction in a food does not necessarily or even ordinarily give rise to the toxic substances involved in food poisoning, and cites as an example limburger cheese, a wholesome food of clean record in the annals of food poisoning. Eskimos eat rotten seal meat and rotten fish and Chinese esteem rotten eggs (piddan). The student is referred to Hintze (1934) for details about the subject which gave rise to the proverb mentioned before, "There is no accounting for tastes." The amateur globe-trotter of yesteryear complained he no longer felt at home when he arrived at a place where the foods were different. Immigrants to America often developed nostalgias for their age-old food patterns when confronted with the many maize dishes, tomatoes, buffalo meat, etc. of the new world. Specialized foodstores and restaurants arose to placate these misgivings and incidentally increased and enlarged the food patterns of the Americans.

Dr. Fitch (1922) wrote a humorous account (not so humorous today) of the "oil-fat loving Siberian Cossacks." When Napoleon was vanquished, there was a large gathering of allied troops in London to celebrate the victory. "The Siberian Cossacks who were among these troops, swarmed around the street lamps, which were at that time lighted with non-petroleum oils (animal oil), and eagerly consumed the oil contained therein." "Also, not long after this peaceful incursion of the Don Cossacks, London experienced a dearth of tallow candles."

Nutrition and the habits connected with nutrition may not belong to dietetics, because food enters the realm of dietetics only after determination of which kind of foodstuff is to be food—worms, beef, bread, or honey, Renner (1944). Nutrition and dietetics do not tell all the story because it is a general law that life has a psychological side, apart from the sociological aspects of Richards' thesis, which is not yet explained on a physical basis.

(Renner points out that habits remain long if they become taboos) This is not only true of foods but of scents, incense, and flowers. Egoism, or the feeling of individuality, predisposes in magic rites to belief that the individual's spear, excreta, or anything in connection with the individual is a part of that individual. [A primitive concept of the autonomous field (see p. 249)]. So too, smells were magic and in some cases odors of rotten carrion came eventually to be considered poisonous.

The rabbit and monkey, and some primal men, will die from starvation rather than eat some strange food known (by nutritionists, of course) to contain the essential amino acids, vitamins, carbohydrates, fats, and minerals. While hunger and appetite cannot be sharply separated under normal modern (occidental) conditions, they may not be concomitants under duress arising in sieges, war captivity, or sudden scarcity of game, as so frequently and mysteriously occurred in our North American forests in colonial times. Hunger drives men to eat rodents (and ersatz rats, which Winston Churchill promised to eat before submitting to Nazi conquest), insects, bark, pets, and his fellows, but these foods are obviously not appetizing.

Taboos, dislikes, abhorrence, fear of hell-fire, and esthetics influence "civilized" man's dietary all out of proportion to knowledge or data of the disciplines of biological sciences. Beneficial taboos arising through trial and error are, fortunately, numerous. Eating flesh of animals dying of diseases or found dead may result in distress or death, although the Highlander until recent times enjoyed his braxies—mutton from diseased sheep "killed to save their lives." Meat inspection developed by the Danes, Germans, English, and Americans protects the consumer from food-borne disease and allays his esthetic fears.

Lower and upper Paleolithic men, and Henry VIII, gnawed bones with approval of their fellows. Mammoth bones of Predmost, and horse bones of the Solutreans, show the vigor of the practice, but today gastronomists admit only of gnawing chicken bones. We are, for the most part, strange creatures to ourselves and others. The writer witnessed a scene at a university dinner where a famous "human ecologist," or ethnologist, arose and departed in anger and revulsion at the mention of cold-storage chicken! On the other hand, we recall the banquet for visiting scientists held in Russia in 1912 with mammoth meat for fare. Jensen (1949). The age-old flesh, preserved by Nature's refrigeration at the mouth of the Lena River in Siberia, was eaten without serious after-effects for the Paleontologic gourmets who took part in the scientific congress of what was then St. Petersburg. Wolberg (1931), in his studies on the psychology of eating, describes the barbarian esthete of the Brazilian jungles who will place a stick into an ant hole, recline at

ease with the other end of the stick in his mouth so that the succulent ants may crawl into his mouth without more ado. Too, soda fountain employees tell us they observe the sodastraw with mingled emotions.

The Veddas are fond of putrid meat and the Australian aborigines love decayed fatty tissues, like stranded dead whales. "There is nothing in the world more revolting than seeing a graceful native girl stepping out of the carcass of a putrid, bloated whale," Wolberg (1931). The Obbs of Central Africa wash in urine, clean their food vessels in it, and mix it with milk, like our own ancestral stock—the ancient Roman, Celt, Iberian, and others—who cleansed their food vessels and wounds with urine.

Rebellions against food taboos have occurred. Herodotus tells of the desire of marginal delta Egyptians (Marea, Apis) to eat beef like the Libyans, but the oracle of the shrine of Ammon thought otherwise, and these folk again settled into the Egyptian dietary patterns of cereal, milk, lotus, papyrus shoots, olives, fruits, and fish.

Traditional taboos and abhorrences which became rationalized, like beef for Hindus, pork for Jews, horse meat (hippophagy) for Christians, and wine (supposedly) for Mohammedans, fowl generally for Mongols, milk and butter for Malays and Dravidians, and mare's milk for Europeans, to mention a few, began first as the taboo, then avoidance, and finally abhorrence. Why does the modern Englishman fear tainted beef but not tainted fowl? Amerinds preferred cooked foods, but Eskimos ate raw and rotten foods. The Asiatic horsemen of Genghis Khan's horde on their forays both east and westward carried trochar tubes, for bleeding the neck veins of their horses, drinking a few ounces of blood, and then carefully sealing the puncture. [Their modern counterpart's (i.e., the Russian's) mount, the Stalin III tank and halftrack of today, yields only oil; his logistics have changed.] Blood foods and "black puddings" are taboo for many folk, but when the mechanics of blood collection from Government-inspected food animals and fowls will be worked out, the taboo should disappear.

Some of the harmful taboos for primal folk deprive especially pregnant women of the nutrition so necessary in prenatal development. Sir Arthur Keith observed long ago how profoundly important to proper understanding of evolution is embryological development. Nutritionists have made the choice of proper food simple, although politicians have confounded us. There are 30-odd essential nutrients needed every day. The "Basic Seven" classification of needed foods simplifies the necessity for any knowledge of the specific nutrilites. With the development of knowledge, prejudices may be slowly overcome and the optimist sees already the effects of right foods in greater longevity, better health,

better mental outlook (?), and greater happiness (?). The slogan of the food interests and nutritionists is "Good nutrition can add years to your life and life to your years."

We cling to old ways. This reluctance to change for the better, as all pioneers have found, is due largely to laziness of intellect and a certain pusillanimity inherited from faroff ancestors, who were undoubtedly retarded in progress in the distant past even more than people are today.

Histories of invention and thought indicate strongly that man becomes more adept in most endeavors. In just a generation he has discovered the real meaning of nutrition and its bearing on the accelerations noted these past several decades. Improvements of the past have been more noteworthy in culture than in bodily changes. For at least 25,000 years man's somatic evolution appears not to have changed greatly except in head shape, although the cultural differences are very great indeed.

When Sir Gaston Maspero saw an Egyptian shaving his head with a flint blade the fellaheen answered the question of use of less painful instrument, "This was good enough for my father and is good enough for me." He then covered his bleeding scalp with leaves. The Book of Joshua mentions the use of stone knives for circumcision and the Egyptian embalmers used stone knives in Herodotus' time.

To recall other incidents showing resistance to change, the excavations of W. Henzen at the fifth milestone on a slope along the Via Campana revealed an inscription on the stone floor of the temple of *Dea Dia,* "cut by iron tools," which Lanciani (1889) interpreted to signify the hatred of iron inherited from the earlier stone and bronze ages. To expiate the sin of using iron tools, sacrifices were offered, *ob ferri inlationem et elationem,* for their introduction within this sacred precinct. The horror of iron is found in the ritual of the Arval (Arvalian Brotherhood). Sayce (1933) cites many instances where iron seems to have been received with suspicion. Sun-dried earthenware was used by the early Romans, Pliny tells us, but libations were offered to the gods not in crystal or golden vessels but in rough terra cotta *pateroe.* The sacred fire of Vesta burned in an earthern jar and the sacred drinking cup of Numa Pompilius was an archaic terra cotta *tazza.* Changes in food patterns show similar resistances among some groups, but the progressive, alert peoples of all times benefited themselves like the Greeks and Normans with their "eyes on the main chance." The available diets of classical Athens included the "Basic Seven" foundation foods for buoyant health. Only a reckless scholar would question the mental pre-eminence of the well-to-do Athenians. They were not gluttons but men of moderate appetite, like the Normans of the Conquest. Persian visitors to

Athens complained that they arose from the banquet tables hungry—good testimony as to the eating habits of the Persians.

Some human groups climb slowly by their own unaided efforts, but like hybrid vigor, borrowing elements of other cultures or groups (diffusion) has an accelerating effect. More minds are put to work on each process. The Tasmanians, isolated for perhaps 20,000 years, reached a culture level below that of the Arunta of Central Australia (Level 2). Although surviving primal folk have been screened for ages by faulty nutrition, they now appear normal somatically, as we have noted in the adaptations of rice eaters of the Far East to their staple food. Often a marginal area peoples received patterns through diffusion, like northern Europe, and showed efflorescence to an extent that they became donors. The three streams of cultural influence converging on prehistoric Denmark from Hither-Asia and the Mediterranean lands appear to have had this effect. There are examples of the effects on other marginal areas, of diffusion and spread of conquerors, with their new cultures resulting in vigorous, higher culture levels. In the transition of cultures in primitive societies, cultures spread from the conquered to the conqueror.

Class consciousness slows the free permeation of ideas by vertical bars of no intermarriage. Why did rice growing fail to spread into Oceania, and the modern Tahitians disdain rice, although they had the example of the Chinese colonists before them? Why was potato culture confined to the Andes in pre-Columbian times, although wild species occurred in northern South America? Why did the tomato of South America reach northern Columbia only in recent years?

Perhaps novelty, and reaction from religious aspects of the culture, influence borrowings. The western Plains Indians (Crows) used their ancient bows for the sacred sun dance and the ritual slaughter of a bull bison, although they valued rifles highly.

Serendipity

Food technologists, especially those who have patented inventions, agree with the late Dr. M. J. Rosenau (1935), of Harvard Medical School, who focused a new light on invention, discovery, and diffusion. Dr. Walter B. Cannon called his attention to Volume III, page 204, of Horace Walpole's letters (1754), resting patiently on the shelves of libraries these past decades. Walpole playfully boasts that he "has a talisman which can find anything by dipping for it."

"This discovery, indeed, is almost of that kind which I call Serendipity, a very expressive word, which, as I have nothing better to tell

you, I shall endeavor to explain to you: you will understand it better by the derivation than by the definition. I once read a silly fairy tale, called 'The Princes of Serendip;' and as their Highnesses travelled, they were always making discoveries, by accidents and sagacity, of things which they were not in quest of: for instance, one of them discovered that a mule blind of the right eye has travelled the same road lately because the grass was eaten only on the left side, where it was worse than on the right—now do you understand Serendipity?"

Dr. Rosenau observed, in his presidential address delivered before the Society of American Bacteriologists in Chicago: "Kish commanded his son Saul to arise and go seek the lost asses. Saul went out to seek lost asses, but found a kingdom. The outstanding example of Serendipity is the discovery of America. Columbus stumbled by accident and sagacity on an unknown continent. Although he made the voyage to the Indies four times, he died blissfully ignorant of a new world. No one now cares about Columbus' mistakes, nor questions his motives, which were for power and pelf. In his greed for gold and readiness for fight, he was the first of a long line of buccaneers who sailed the Spanish Main. He could not have made his glorious discovery of 'something he was not in quest of' had he not ventured. He did, he dared, and triumphed despite opposition. Walpole tells us that there were three original Princes of Serendip, but he might have crowned Columbus King of the Realm.

"Many a scientific adventurer sails the uncharted seas and sets his course for a certain objective, only to find unknown land and unsuspected ports in strange parts. To reach such harbors, he must ship and sail, do and dare; he must quest and question. These chance discoveries are called 'accidental,' but there is nothing fortuitous about them, for laggards drift by a haven that may be a heaven. They pass by ports of opportunity. Only the determined searcher, who is not afraid to seek, to work, to try, who is inquisitive and alert to find, will come back to his home port with discovery in his cargo.

"There have been those who would belittle the work of our patron saint Pasteur, by insinuating that as a Prince in Serendip, his results were achieved more by accident than by sagacity. What a distorted viewpoint of a genius whose unremitting toil and zeal gave so much to the happiness of the world and the security of life! . . . Chance and accidental discoveries in scientific research come only through preparation by toil and thought.

"The natural tendency of the unprepared mind is to discard the unusual. It is dismissed because not wanted—it does not conform to the

preconceived plan. The unusual and unexpected may be significant and perhaps have to wait for a blunderer from Serendip on a journey of adventure in quest of discovery. In other words, what may be called the by-products in research are often more important than the primary aim of the study. The by-products of industry are often its most useful and profitable products; but we cannot have by-products unless we make products.

"The secondary effects of science itself may be even more valuable than the actual discoveries that are acclaimed. One of these secondary effects is the infiltration of the scientific method into the mode and thought and attitude of herd psychology. It has taught a frank facing of realities calmly and impersonally. It has shattered shackles and traditions and superstitions that have long chained our attitudes and methods of thought. It gives us a clearer understanding of the world in which we live and permits us to sound deeper into the well of truth. It is no longer impious to question, to doubt. All our problems, even those of an emotional nature, may now be discussed with calm detachment. This attitude has had a profound influence upon society, its morality, its ethics, and its thinking. These adventures into the realm of reality are not accidental blunders in the sense of Serendipity, but inevitable by-products of the scientific method.

"It has become a twice-told tale to recount the triumphs of preventive medicine. The control of disease has made life longer and surer. Longevity, however, is a poor index of progress. It is no use to live longer unless we can live better. In other words, progress is measured in spiritual rather than material terms."

Some enthologists find societies in which the germs of further development seem to have been effectively killed. We must not overlook the nutritional status of these folk over a long period of time. The self-inflicted wounds of the starving poet and painter in the proverbial attic on the left bank of the Seine might heal more rapidly with more, and better selection of, foods. Starvation and necessity have, however, spurred some folk to better themselves. The ingenuity of prehistoric man in devising and developing seines, fish weirs, weapons of the hunter, and 60 or more major discoveries up to the literate period is fully appreciated by archaeologists and technologists. The major metal tools were invented in the Iron Age. Extension of this power today is just the progression initiated by eolithic tools of half a million years ago! The technological revolution sometime before 5500 B.C. and the domestication of plants and animals, made possible a new mastery which tremendously accelerated the accumulation of culture. Thereafter the

acceleration grew steadily, until by now more is probably added in a day than was added at the beginning in a hundred thousand years. [Braidwood, Krogman, and Tax (1946).] Pure scientists and applied scientists like inventors, both great and obscure, during the millenniums, are compared by Mr. Charles F. Kettering to the warp and woof of a fabric. "Just try to sleep in a hammock which is all warp and no woof!"

Wherever agriculture appears early in the Old World or the New, there also is a site of an early civilization, and when spread to a new area, there, too, civilization tends to appear. Better nutrition over the life-span cannot be discounted as a major cause of sudden efflorescence of cultures. Certainly the humanitarian views of today would not invoke racial superiority, although in the far past Sumerians looked down on Semites, Semites on Egyptians, Egyptians on Hittites, Nubians, and Libyans, Aegeans on Greeks, Greeks on Romans, and the Romans on Germans.

Then from 1700 to 1939 A.D. the process reversed from north to south and even the loyal Orkneyman described Britain as an island lying south of Scapa Flow!

Genius has outcropped among all folk and has ever done so, though often it could not flourish for lack of opportunity. There were great men before Imhotep, the first great man of the historical period. Sayce (1933) calls attention to changes in culture brought about by some dominant or inspired personality. Discoveries, both independent and simultaneous, are well known to scientists and Examiners of the Patent Office. Accumulation of seemingly unrelated data (furnished by humble men in their labors), ultimately going back to the dim past, and correlation of these (pertinent) data, result in any invention or discovery one wishes to mention. Faulty nutrition and its intricate train of events, like disappearance of useful arts and their rediscovery with better nutritional times, is the major environmental influence in "decline and fall," or displacement by new technologies arising from new needs. Toolmaking spearheaded the progress of man in his quests. Man thus made himself, but it is apparent that machines and weapons have in turn remarkably influenced his living. Set, routine machine jobs and his ingenious weapons for warfare may eventually destroy him.

The Norse scholar, Schjelderup-Ebbe, about a quarter of a century ago observed that hens living closely confined showed a fixed order of dominance, or peck. One hen can peck any of the others without retaliation, and at the other end, one hen is pecked by all the others. The other hens have castes and lord it over their companions like humans must necessarily do in the armed forces, State, and unions. Nutrition and hormones also influence dominance, W. C. Allee (1938).

CHAPTER XII

Early Preparations of Foods

Use of Fire in Food-Gathering Times

While Rabelais had not the interest in food evidenced by Brillat-Savarin or Apicius, he called attention in his inimitable manner (Book 4, No. 58) to "Messer Gaster, the stomach, the first master of arts in the world and the inventor of all devices, trades, and refinements." "You cannot," he says, "make him (the stomach) believe anything, remonstrate with him or persuade him, for he has no ears. He will have no delays when he calls; when he issues an order, you must obey at once or die. The wild animals inhabiting the forest, the air or the water obey at first sign. All for tripe."

The Edinburgh Review of April, 1814, discussing food conservation and the work of Appert, the first canner, stated: "The most philosophical definition, as well as the most honorable prerogative of man, as is well known to every member of the Common Council, is, that he is a 'cooking animal'; and we believe it may be safely asserted, that he has scarcely ever been found in so very lamentable a state of barbarity, as to swallow his food without some kind of preparation." In 1947, Dr. C. O. Sauer observed, "There is no certain record of humans before they knew the use of fire."

We have seen *Sinanthropus* of half a million years ago, with his long-extinct fires and now fossil charcoal, roast his meat, as we surmise his Java cousin must have done. Dartians of long ages before him were perhaps fire-using, and certainly later Paleolithic men, both Neanderthalians and Cromagnards, had developed roasting and cooking devices for meat, fish, and shellfish. *Homo sapiens* and his immediate predecessors succeeded in breaking away from the helplessness of all living things that went before them (except migratory fowl), imposed by food and climate. Man devised warm clothing and fire in shelters, and tools and devices to extend the usefulness of his nonspecialized hands and feet. The Arctic-tundra animals, rich in protein nutrilites and fats, provided him with stamina to survive over a tremendous span of time. The *specific dynamic action* of fat-rich meats containing an adequate supply of nutrilites provided him with the best nutritional pattern for the strenuous arctic life (see pp. 188-189).

Like the lower animals, earliest food-gathering man hunted and fished, gathered fruits, nuts, moss, tubers and shoots in season, and

seized eagerly upon small animals, snakes, lizards, and insects. Later man hunted the huge mammals of the Pleistocene. This economy, and such it must be called, was effective, judging from the ages it carried primitive man over his longest span of time—a wider space of growth and change than any other system known to us, Gras (1946).

In the childhood of man he lived for the present; yesterday he was hungry, today satiated; thunder, lightning, tempest, and beasts of prey made him wretched; in sunshine and calm he was content; at night he was fearful of all that moved!

How man was induced to domesticate fire, so terrifying to animals and the lower primates, is not known. Spontaneous fires from lightning or volcanic activity, may have left dead, scorched animals. Smoldering punk of trees, roots, and resinous wood gave him his fire for use in caves and elsewhere, and could be carried about. Keeping of permanent fire sources must have been practiced right down through the epochs, since in historic time it is a firmly established ritualistic practice. Steps from preserving fire to starting a new fire were spontaneous and rapid, but friction and flint-spark fires were inventions of the first magnitude.

It appears that meats were first roasted on spits or in hot ashes and embers. Boiling foods came in with hot-stone baskets, rock and earth pot holes, and finally pottery, but the idea of boiling or steaming may have been conceived by observing steam and hot juices exuding from roasting meats.

Primal man's hunt for food was and is his major occupation. Obviously, there is no life without food. Historians up to recent times of North Atlantic civilization seemed reticent to mention foodstuffs. Carlyle's complaint seemed to sum up the status of man's chief necessities. With the comparatively sudden efflorescence of biological research, especially in biochemistry and nutrition, new light has illuminated an old horizon. The enlargement of the supply and kinds of foodstuffs was the single greatest factor for man's progress, together with selection of proper nutritive foods which make up an adequate, balanced diet.

Primitive men were improvident. From food orgies that were nearly fatal, they passed into long periods when they had only roots to grub, or bark or insects to eat. There were undoubtedly long periods of starvation and then gluttony of the worst kind when a kill was made—a terrifying scene of debauch.

Food-gathering and hunting men must have lived under frightfully insanitary conditions in their natural shelters, judging from the fossil debris of their own living. After gnawing a bone clean of succulent meat or breaking it for marrow, it was thrown into the back of the cave,

or shelter, and the ashes of their fires merely scraped aside when they became too deep or cumbersome. Century after century these accumulations grew until many caves were almost filled with man's accumulations of living. In some European camp-sites, the fossil debris measures 60 feet deep, fortunately for the student of ancient man, because the leavings are composed of the bones of animals, nuts, and vegetables he ate, his tools and chips. The animal bones themselves show how men used their flint knives and scrapers. They were not too particular what kind of meat fell before their weapons and into their traps. However, any piece of fresh meat smells and tastes good when roasted over an open fire, as at the picnic-barbecues of today.

Paleolithic man often made fireplaces by lining a hollow with suitable pieces of stone. When the stones were hot, the burning wood was removed and replaced by meat, fish, or shellfish wrapped in leaves, covered with earth, and left to bake until done. A bladder, skin, hide, shell, or hollow long bone could be used to carry water and even to boil water by means of adding hot stones. These "pot boilers" are easily recognized and are still in use today by primal folk, who also use hammer-stones to break nuts, and drinking tubes of gourds, shells, horns, skulls, or broken ends of the large marrow bones.

Pots and Pans

In the pre-ceramic epochs, man discovered and invented by force of circumstance, not by divine right, Harrison (1928). The story of the potter is one of slow additional steps and then a giant stride in the Neolithic. "Man borrowed the brains of others long before he had money to lend," writes Dr. Harrison.

Man of pre-ceramic times made circular baskets and it is surmised that the prior art is closely connected with pottery. Dr. C. S. Coon (1951) has shown that in the Belt Cave of Iran, meat and marrow soup cookery was done in Mesolithic times by boiling in perishable basketry or in skin-lined holes in the ground. Herodotus describes these hot stone cookery methods in use among the Scythians. This hot stone method has been used far through time and space and was employed by the California Indians. The first step in pottery making may have originated in clay plastering of wattle and wicker—in Neolithic times of "wattle-and-daub." Hardening of clay by fire was known before pottery. Perhaps a clay-daubed basket was burned, leaving behind baked clay retaining a proper form. In North Nigeria are tribes who plaster clay on the outsides of baskets which are then burned into pots. It may be that molding in baskets made in the coiled manner was followed by the coiling

method in building a pot. Ertebolle pottery was built in coils, which indicates coiled basketry is very old. Horns of cattle and bison had been used as vessels and trumpets since Aurignacian times. The plasticity of clay was the determining factor and a long chain of events ensued which is so well described by Harrison (1928).

Western Europe learned to make pottery about 5,000 years ago by processes coming in slowly from the ancient Near East, where the first boiler pots may have originated about 6,000 to 8,000 years ago. The first potters were, in the majority of cases, women, and pots were made by them perhaps when settlements formed. The potter's wheel was not developed until settled life was well established, in the later stages when surpluses of food were available.

Glazed, uncracked pots and food vessels were needed for cleanliness, as anyone knows who has washed utensils after a meal in camp or field. The ornamental marking (grains, cords) and coloring of pots comprises a voluminous subject not within the ambit of this book; suffice it to say here that red ocher paint was known and used for supramundane purposes in the old Stone Age. It is not surprising that sooner or later it was tried on pottery, resulting in red and black polished wares. Porosity of fired clay vessels of prehistoric times, and later times as well, was effected by mixing cattail down, chaff, powdered grasses, etc., in the clays. Water in these jars cooled through evaporation.

The history of ceramics and nutrition gives us an all-important fact about boiling-pots—man added vegetables, grains, salt, and herbs to his boiling meats and the chef's art began. The field was open for cookbooks. The basis was laid for arguments about nutrition and food sanitation, but refinements were a long time coming, Jensen (1949). The hot flame fires of semiarid vegetation were needed for good pottery.

Pottery showed up first in the Middle East. Man no longer needed to be wasteful of food when pottery was used, in comparison to the waste in roasting. The art of pottery making did not develop until Neolithic times and was invented independently in the Old World and in the New World.

Effects of Cookery

Ability to get the wished-for food is one of the important factors in the evolution of man's diet. Intelligence counts for a great deal in successful food quests. A stupid animal must be content with a bulky, monotonous food, whereas the clever animals, primates, rats, and squirrels, exhibit their superiority over herbivorous animals by their "cleverness" in obtaining more concentrated foods, hence their digestive

apparatus is much less bulky. The diet of the great apes and monkeys is mainly coarse food, mostly vegetation, but they do eat some animal matter—birds, eggs, lizards, grubs, insects—and honey, and grains. West African monkeys are fond of shellfish and oysters, Fitch (1922). Lower Paleolithic man no doubt ate the same sort of foods. Climates in the changing world of the Pleistocene needed to be tropical or subtropical for these foods to be easily obtainable. Some monkeys and baboons fight like primitive man by throwing stones or missiles—fighting usually for feeding grounds—a cause of war down through the ages. Spanish observers of early days in South America reported the primitive Mycetes monkeys defending themselves by throwing stones, and Yves d' Evreux reported seeing monkeys break oyster shells and also crack nuts and fruits with stones! However, much of the food of anthropoids is unsuitable for humans, indicating that evolution of man is concomitant with nutrition. The configuration of the digestive apparatus and organs of anthropoids evidences descent from animals with large caeca, a corollary of a bulky diet. The tendency of the evolving primate was to abandon the strict vegetarian diet and to eat some flesh.

We have noted before how the discovery of cookery, roasting and tendering meats, profoundly affected man's masticatory apparatus, with the concomitant changes in his facial and cranial structures. Palatability and food acceptances were long steps in man's welfare. Heat-coagulated proteins, whether of flesh or eggs, are more digestible than raw proteins, although most investigators believe raw meat to be easily digested. We recall the "invalid's diet" of yesteryear, eggnogs, "very soft boiled eggs," Beef Tartare, and the like which turned out to be the wrong diet after all! The gastric juice—pepsin and hydrochloric acid—does not attack raw egg albumin *in vitro* or *in vivo* to the fullest extent, as Dr. Northrup and Dr. T. L. McMeekin showed independently. To be sure, some birds of prey can digest keratin, but man has a relatively tender stomach. Cooking made starches more digestible and indeed some dietitians postulate that until the invention of wet cookery, the stomach of early man had but little acquaintance with undigested starch, unless the starchy food was well masticated, i.e., Fletcherized, and split by the salivary enzymes in the mouth. Mechanically, it is possible for food proteins to be prepared in such a form that it is difficult for the digestive juices to act upon them. The question is largely one of physical texture, fineness of division, and freedom from occlusion by indigestible surfaces. For instance, heavy dark pumpernickel, according to Meyer, is only 60 per cent utilized so far as its protein content is concerned. The proteins of wheat and barley, corn, beans, and peas are digested and

absorbed as completely as in lean meat, if they are freed of protective coatings of cellulose and fed in a state of fine division. Fat-fried meat and vegetables may retard digestive processes. Wolf and Osterberg (1912) found that in a healthy man, over 40 per cent of egg albumin eaten raw passed through the gastro-intestinal tract unchanged and so without food value. Cooked, coagulated albumin was digested very well.

Dietary iodine is always needed, but Greer (1950) calls attention to the goitrogenic foods, cabbage of certain varieties, rutabagas, turnips, and some other vegetables that possess antithyroid action. A harmful substance, L-5-*vinyl-2 thio-oxazolidone,* which is destroyed by proper cooking of vegetables should dampen the enthusiasm of some faddists who recommend raw vegetables for "health." We need not linger on the curative and prophylactic effects of iodine on the thyroid, except to note that the Egyptians (Ebers papyrus, 1500 B.C.) and early Chinese treated goiter with iodine-containing substances like burnt sponges.

The thiamin-destroying enzyme (thiaminase) in raw fish which causes Chastek's paralysis is destroyed by cooking. Phytin (a mixed salt of potassium, calcium, magnesium with inositol-hexa phosphoric acid, which is the principal form of phosphorus in wheat and other grains and seeds) renders calcium inert but is destroyed in cooking and by fermentation as in bread and beer. Walker (1951) finds that phytic acid may not be an anticalcifying agent in human nutrition. Well-cooked proteins tend to counteract selenium toxicity. Avidin of raw egg-white combines with biotin, which may precipitate biotin deficiency. We need not speculate at all on the boon of culinary heating in respect to destruction of pathogenic bacteria, molds, parasitic worms, viruses, and the toxins of *Clostridium botulinum.*

The savor of "cracked" amino acids in roasting meats and the prevention of "burned," unsavory meats eventually led to care in food preparation and the invention of the gridiron devices.

Cooking, proper roasting, steaming, and baking of meats and vegetables do not impair significantly nutritional values, as was once thought. Cooked foods need no defense except in prevention of subsequent contamination by food-poisoning and putrefying bacteria. Cooked meats tend to spoil more rapidly than raw meats.

Boiling of water was discovered long after roasting, baking, or steaming, though natural hot pools and springs exist in many parts of the world. The know-how for boiling water was long an insurmountable obstacle to Pleistocene man. The New Zealand natural hot water springs, and those of Iceland, Yellowstone, and elsewhere were taken

advantage of by the Maoris, Vikings, and Indians. There were tribes in our time which did not know how to boil water—Fugeans, Bushmen, and Australian aborigines, Fitch (1922).

Greeks of Homer's era were not good cooks and his description of Achilles receiving three noble Greeks, one of whom was a king, shows their manner of feasting was rude. The meat—pork, mutton, goat—was grilled in a bronze vase over a hot fire. Bread and wine were the only other foods served. Homer never refers to boiling foods or boiled meat. The Egyptians of this period, as well as the Hebrews who had sojourned in Egypt, had cooking utensils which they placed on the fire, and they boiled a good deal of their food. The Bible student recalls the crafty Jacob who, using boiling-pots, prepared a mess of potage from red lentils, which was the means of dispossessing the trusting Esau of his birthright.

No true cooking was known until cooking pots became generally used. Symington Grieve (1885) tells of specific hot-stone cookery in prehistoric Scotland of the Cruithne or Picts, whose past is just coming to light and who figure so large in the folklore of Scotland and Ireland. These people subsisted on fish and shellfish and used heated flat basement stones and round water-rolled stones in pits. The food to be cooked (rolled in seaweed) was laid upon the heated flat stones and the rolled stones were then placed over the food to be cooked, and the pit covered with sand. The mound folk (Sithean) knew by experience the cooking period needed.

These stones even now, especially the rolled stones, show fractures and darkening from heat and smoke. Close to the fire-pits were found lumps of gummy material composed of scales of mullet and wrasse. It was customary with these folk of ancient Ireland, Inner Hebrides, Scotland, and Denmark to peel off the skins of coarse fish after pit-cooking. These interesting remains have survived the ravages of several thousand years according to some observers; others believe the practice was discontinued not so long ago, historically speaking. Witness the clambakes of their modern descendants in America!

The rapid development of pottery making among Neolithic peoples came about with great need for cereal cookery, milk containers, brewing, and storage of foods. Pottery and baskets also took the place of shelves and boxes. Large earthenware was used for storage and the smaller pots for cooking, eating utensils, and beverages. The Paleolithic and Mesolithic peoples could cook most of their foods by simple roasting on spits.

The addition of carbohydrate-rich materials, like cereals and vegetables, to meat (beef) stews often stabilizes thiamin (B_1), although

potatoes do not appear to exert this effect. The old admonition, "Suppe not loude thy potage no time in alle thy life," is still the modern view of "slurp."

Poisonous Plants

Hahn (1919) observed complicated methods used by primitive man for preservation of food. Methods of rendering foodstuffs more palatable were discernible everywhere. No doubt there was a great deal of poisoning as a result of searching the vegetable kingdom for comestibles. No one knows how many humans from the Pleistocene on through the Holocene, or present era, were poisoned by mushrooms, nightshade, or deceptive berries. Primal man learned that certain nuts, fruits, berries, leaves, roots, grains, mushrooms, shellfish, and snails could cause diarrhea, vomiting, convulsions, and even death. Flies, mosquitoes, bees, hornets, spiders, and arachnids could sting, and snakes could kill. He learned of vegetable and animal poisons to poison his darts and arrows and thus he could kill large animals and enemies with ease. In Job (VI: 4) poisoned arrows are mentioned, but the great antiquity of toxic darts may be inferred from the practices among living primal men, who are toxicologists of no mean ability. Extracts of the rotenone-containing plants, like the "devil's shoestring" of North America, and buckeye nut extracts, for example, have had almost global use for stupefying fish. Fish caught in this manner can be eaten with impunity by humans.

Living Pygmies of Africa, and some other tribes, if in doubt of poisonous qualities of a new fruit, vegetable, or other food, soak it for three days in water and feed it to one of their dogs. If the dog does not become ill, they try it themselves. Hence, if some unpleasant or poisonous substance, macerated and cooked, becomes edible, primal man has a new food but no monetary benefit or scientific honors. Many early folk were good herbalists and we find the Aztecs of Mexico had botanical gardens of medicinal herbs staffed with teachers and pupils, much the same as in some of the early cultures of the Old World.

The often-cited example of primal man's ingenuity in processing manioc (cassava, tapioca) to free it of prussic acid or hydrogen cyanide is interesting indeed to present-day food technologists. Manioc tubers *(Manihot utilissima)* contain as much as 0.07 per cent cyanide in the raw root. Some analytical chemists give an even higher figure. The tubers weigh several pounds and are rich in starch, fat (8.6 per cent), protein (11.25 per cent), and minerals (1.04 per cent ash), with about four per cent fiber and 25 per cent moisture. To detoxify the tubers, primal Amazonians slice the roots, soak in water 24 hours with a piece

of rotten manioc added as a mother-culture of microorganisms (like our yeast and lactic acid starters), to promote fermentation which converts the cyanide to nonpoisonous compounds. The slices are then grated on palm spine-studded boards and packed into a unique squeezer of plaited palm bark over seven feet long (like toy finger-traps). One end of the cassava squeezer is attached to a rafter or bough; the other end is weighted by a woman sitting on a stout stick, and in this manner most of the juice is expressed. The pulp is spread to dry and powdered by hand. This flour is heated in a platter and stirred vigorously to drive off any residual cyanide. The flour is then kneaded with water and baked in cake dishes. The expressed fluid from the squeezer is concentrated to a paste by boiling, seasoned with peppers, and cut-up fish, and used as sauce for the cassava cakes. The residual liquid has also been used to preserve meats from flies and other pests.

Sacramento Valley acorn flour was prepared by pounding and then dampened in a sandy hollow. Over this a layer of cedar sprigs was laid to keep the meal *in situ,* and warm water, heated in baskets by hot stones, poured gently until the hollow was filled. The moisture slowly soaked away; then a second lot of water somewhat hotter, and finally boiling water, was used for leaching. The squaw, like a soap maker, tasted the flour, until she found all the bitter principle dissolved out. The flour made sweet cakes.

Toxic substances are produced in plants as a result of their metabolism. It is not possible to divide plants into poisonous or nonpoisonous at one certain stage of growth. (Some plants are poisonous in one stage of growth but not in another.) Seeds or fruits may be poisonous, but the parent plant may not be. On the other hand, some plants are poisonous to some genera or species of animals and not to others. For instance, the cockleburr *(Xanthium orientale),* and related forms, is very poisonous to swine (glucoside, xanthostrumarin), while wild barley may injure some animals but not goats. Some humans are "immune" to ivy and dermatitis-producing vegetation; others are sensitive to contact poisons.

Most toxic effects obviously arise from ingestion of poisonous principles in vegetation and may act by (a) toxic alkaloids like coniine of hemlock; (b) substances harmless until acted upon by digestive juices, like glucosides (amygdalin of wild cherries) hydrolyzed to form hydrocyanic acid; (c) fungi growing on plants, like ergot on rye.

A few plants contain oxalic acid in poisonous quantities (rhubarb leaf blades, not the petioles); some plants absorb selenium from the soil; some cause photo-sensitization, like buckwheat in sun-exposed, light-skinned peoples but not dark whites or colored. India wheat, St. John's

wort, "bunch-grass," or alsike clover do no harm if the animal or man keeps out of the sunlight. Poisonous seeds may be found in mustards, peppergrasses, wild radish, and castor bean.

Selenium from soils of Cretaceous and Eocene shales has had its effect in the western American plains animals and man. General Custer's cavalry horses at the Battle of Little Big Horn may have suffered from selenium poisoning.

Early man and all pioneer stock emigrating into a pristine, uninhabited environment were forced to experiment with new flora. The ingenious methods of roasting, boiling, and drying of certain nuts and berries, to render them non-toxic testifies to the acumen of, and no doubt trial-and-fatal-error experienced by, some tribes.

There are over 400 species of poisonous plants; the families of plants most likely to harbor poisons are Compositae, Solanaceae, Liliaceae, Ranunculaceae, Umbelliferae, and Leguminosae. The terrible milk sickness which plagued American pioneers (Lincoln's mother is said to have died from this form of poisoning) is caused by consuming milk from cattle eating white snakeroot *(Eupatorium urticae folium)* which contains tremetol, a higher alcohol, in its leaves and stems. This compound is fat-soluble and passes into the butter-fat.

Barley and barley beer with spiny, sharp awns (chaff) can cause mechanical injury to man and animals. Abortives like tansy, and ergot in rye, have had their effects. The striking action of some plants on the tissues of animals and man started the early herbalist off on his medical career. For instance, young brakefern shoots *(Pteridium latiusculum)* can be eaten like asparagus if cooked, but the fresh fronds are poisonous, the symptoms being delayed several weeks (dyspepsia, fever, hemorrhages of organs).

Acorns and oak leaves are poisonous to cattle and the castor-oil bean poison, *ricin,* was used in the ancient East for political purposes. Linseed meal is detoxified simply by soaking in water overnight and then drying.

There are fearful descriptions of ergot poisoning from rye, especially in the Middle Ages. In the early autumn of 943 A.D. over 40,000 fatalities occurred in Limoges, France. The Romans avoided infected rye, but St. Anthony's Fire, or ergotism, was not quenched until 1600 A.D. when Kaspar Schwenckfeld discovered the true cause of this dreadful disease. There is some indication, however, that Caesar's legions at Marseilles suffered an outbreak of ergotism. Ergotism occurs as a result of eating a parasitic fungus, *Claviceps purpurea,* which contains a neurotoxin and necrotoxin. The fungus grows on rye and other

grains as a blackish mass discoloring the meal. The disease comes on gradually after an infected harvest, and is characterized by gangrene of fingers, toes, ears, and nose, convulsions, mental depression, weakness, drowsiness, headache, cramps and itching, abortion, and sensations of intense heat. In western Europe the gangrenous type prevailed, but in eastern Europe the convulsive type was usual.

Salting and Preserving Foods

We have dealt with this aspect of early and modern food technology elsewhere, Jensen (1945, 1949). In Roman times, according to Seneca, snow was used to pack prawns and other perishable foods. The supply of ice was usually snow, packed in chaff or packed in straw pits which solidified the snow into "snow-ice." This practice was highly insanitary, since microorganisms do not die off in this type of ice upon storage, Jensen (1943). Supplies of ice and snow were obtained from mountains and because of obvious expense were not much used. Plutarch mentioned how chaff prevented melting of snow and Athenaeus described how snow was added to food and drink by Alexander the Great, the ice-water being strained through cloth for "purification." This was an excellent vector of infection and Pliny (XXXI, 2) stated that drinking iced beverages produced illnesses of every kind. Thereafter Nero chilled his drinks in jars placed in ice or snow.

Placing foods, especially meat and meat foods, in edible oils, usually olive oil, was a widespread practice of preservation in ancient times. This food-in-oil method did not, however, safeguard foods and the practice, which is still employed today in country districts, leads to a high incidence of *staphylococcus* food poisoning.

Vinegar and salt, or both substances together, were used as preservatives for fish and meats. Herodotus writes, "many kinds of fish the Egyptians eat raw, either salted, or dried in the sun." The arts of mummification and preservation of foods are supposed to have influenced each other in turn. Salt may have been considered divine by the Nilotes because the natron used (salt and carbonate) preserved bodies from decay after the soul had left, and we quote but do not endorse, "because mice conceived without sexual intercourse by merely licking salt!" A faint echo in this connection was heard by Dr. Jacques Loeb, who was the first to discover that certain mixtures of salt solutions fertilized sea-urchins' eggs, and was later asked by two timid old maids if sea bathing was hazardous in this respect.

Archaeologists have found well-preserved salt fish at Esna, Egypt. The specimens were fresh in appearance. The whole fish had been covered with clay to exclude air.

In the ancient Jewish kingdom salt was in common use owing to the excellent supply from the Dead Sea. Its use by these people in nutrition and in sacrificial offerings was to be expected. Freydank has written that the newborn children of the ancient Jews were not washed but cleansed by rubbing with salt. Salt was considered an essential by the ancient Babylonians. These people also pickled fresh and salt-water fish. In China salt has been prized since the earliest times. The working up of sea salt must have been known by 2200 B.C. (long chronology), because Emperor Yu of the Hia Dynasty imposed the first salt taxes at that time, in Tsing-Tau.

The use of salt as a preservative was long practiced in ancient Greece. It was obtained from "salt gardens," though the people knew also of rock salt. The salting of fish was common and salt-fish formed a cheap article of diet for workers and slaves. Several kinds and qualities of salted fish were common.

The ancient Romans learned the use of salt from the Greeks and they used it extensively in curing fish. They differentiated between rock salt and sea salt. Salted fish products were much used and exported. They also prepared products composed of meat and fish with other ingredients, all salted. Finally, they knew how to pickle the flesh of food animals, and pickled pork products were known and were sold at a high price.

The solar sea salts of ancient times often imparted bitter flavor to foods because they contained impurities like magnesium sulfate. Pavlov found 0.3 per cent magnesium sulfate to impart bitter tastes to butter, and magnesium chloride in salt is very bitter. However, solar sea salts are liked by certain nationals for sausages and sardines. Mineral and microbiological impurities in some solar sea salts tend to lessen preservative powers and these salts do not preserve meats well, L. B. Jensen (1944).

CHAPTER XIII

Nutrition and Bodily Changes

Teeth, Jaws, and Mastication

It is interesting to think that man through his long development of cultures and nutrition had modified by his own devices his bodily form as suggested by Professors C. S. Coon (1939) and V. Gordon Childe (1948c). There was a reduction of size of face, jaw, and masticatory structures of Pleistocene man. *Homo sapiens* also did not stop evolving. Chief among the stimuli for these changes were undoubtedly nutritional influences, M. F. Ashley-Montagu (1935). Weidenreich (1939b), however, did not believe that a mere change in food habits could be responsible for the reduction and simplification of the human dentition. This change occurred in upper Paleolithic Europeans during a long span of time, but it is widely held that differences in physical types resulted more in response to environment than origin.

Among Berbers and some Balkan mountaineers the upper and lower incisors meet edge to edge, which was also the case with most of medieval peoples of western Europe. The recent changes to overbite, according to Professor C. S. Coon (1939), are accompanied by narrowing of the palate, crowding of the teeth, and changing of position of the lips, thus changing the entire facial expression. Studies of portraits, as well as skeletal remains, show these changes. Masticatory insufficiency, resulting in inadequate ability to chew food, leads to alimentary tract disturbances, and especially to malnourishment and evidences of pellagra, beriberi, scurvy, and riboflavin deficiencies. The vertical dimension of the face was found to be less than normal under these conditions (Nutritional Rev. 8, 149, 1950). H. H. Neumann (1948) sees a relationship between degree of masticatory function and incidence of tooth decay. Underfunctioning of teeth, jaws, and masticatory muscles may result in atrophic teeth, which are highly susceptible to tooth decay. This idea merits exploration (Nutritional Rev. 8, 344-346, 1950). Soft diets may lead to higher water content of teeth than food requiring vigorous mastication, and thus the incidence of caries may be higher in case of soft diets. Theories on the etiology of tooth decay are too numerous to review here (see Jeans *et al.,* 1952), but a clear fact stands out in case of many so-called primitive peoples. All "aborigines" like Eskimo and Sioux Indians had excellent teeth before occidental contacts, even in old age. One theory of dental troubles which still holds its own among modern

theories is that of the Iowa chief who with his 14 braves was taken on a tour to the East and England by A. Catlin (1861), the famous ethnologist who visited the Mandans in 1832: "All white men have rotten crooked teeth from number of lies which pass over them!"

Tooth size and patterns are criteria of evolutionary change. Tooth reduction apparently goes on, but Neanderthal teeth were big like the teeth of contemporary survivors (Australoids, Negroids, and some Amerinds). The smaller teeth of most humans of many ethnic groups seem to be independent of special diets. It is often stated that usage and nutrition affect the size of teeth and jaws.

Re-emergence and Head Shapes

Where one Paleanthropic feature is seen, the others usually accompany it, i.e., skull thickness, tooth patterns, massive jaws and lipping chin, brow ridges with buttressing tori of lower jaws, and occipital torus. The shape of certain fossil skulls depended upon the insertion structures of the jaw and anatomy of the muscles involved.

The shape of the head may be affected by nutrition, Montagu (1945), and iodine deficiency has been asserted to induce head-shape variability in experimental dogs. We have mentioned before the effect of foods and masticatory apparatus upon the shape of the head and upon man's evolution.

Dr. S. L. Washburn (1951), of the University of Chicago, has been able to modify the skull form of rats by cutting various muscles in a way that parallels evolutionary steps. It can be inferred from these laboratory studies by Dr. Washburn that changes in bony structure may not have required long, slow evolutionary steps for their development. For example, the change from the pronounced brow ridges of the ape man to the smoother forehead of modern man may have resulted from a few drastic changes in the muscles of the head and neck.

Aside from the purely mechanical facets inducing change, we must not lose sight of the fact that biocatalysts, ferments, enzymes, and the necessary regulators of the body are manufactured out of food! What unknown influences bear on the evolutionary process through age-long ingestion of restricted foods? All tissues are constantly being replaced by nutrilites from the diet. Calcium in bones has been found to be replaced in about eight weeks. Certainly, the long-range actions must result in change in spite of genetical control, as both genes and plasmagenes are now pictured. Our shorter vision perceives clearly the nutritional influence on character and psychosomatic behavior. It has been asserted that just like psychological memory, so there may be a

somatic "memory" which may not be effaced in the lifetime of the individual or the subrace. Nutritional factors affect weight or soft parts markedly more than they do bone, but generations of special diets have their effect on both osteological tissues and soft tissues. At the present time we must use phenotype instead of genotype for the majority of human characteristics and the nutritional background which helped shape this phenotype must be known.

In general, Pleistocene and Paleolithic heads were dolichocephalic, whereas living races show about equal distribution on both sides of the 77 to 79 index, or the breadth-length proportion. From the metrical proportion of the skull, the development of the anterior lobes of the brain can be learned, and these developments are good indications of evolutionary development.

As we have noted elsewhere, there were mixtures of *Homo sapiens* with Neanderthaloids, as evidenced by the type of Mount Carmel where the Tabun group was frankly Neanderthal and the Skhul group resembled *Homo sapiens* with intergrading types. The Predmost people of Brunn in Moravia also showed these types. Aside from race mixing, it would appear from the work of Boas, Shapiro, Dornfeldt, and others that latent potentialities for head shape may come to the fore in different environments and with different food supplies. Foods in this case may be classed under the general rubric of climate-soil, since the availability and kinds of foods were determined largely by climatic conditions and the chemical terrain upon which plants and animals flourished.

With one possible exception, brachycranial skulls seem not to have existed until our race, *Homo sapiens,* appeared. There appeared with his advent powerful and slight physiques, short and long faces, blond and brunet types, and certainly, round and long heads. The food factor, if it enters at all into the diversity of types of Cromagnard times of Europe, may be found in the plentiful supply of protein-fat-rich foods. Often diversity of types indicates progression and certainly art and magic flourished in a comparatively exalted form for the first time in man's long history. Some technologists believe that making of fire by means of flint sparks by these folk was the greatest invention of the upper Paleolithic.

The causes of differentiation, outside of classical genetical concepts, mutation, and "latent prepotencies," are amalgamation, selection, and environmental response. Race is never static, but always in process of change. The effects of complex migrations of mankind have complicated the task of anthropologists in all of their studies, but an interesting fact emerges. Given geographical areas do present a general picture of

stability of types, or re-emergence of types, as Ripley pointed out a half-century ago in his "Races of Europe." While there is a general re-emergence of brachycranes seen from upper Paleolithic times, the phenomenon has been going on apace these past 500 years. A. D. Lacaille (1947) described the earliest known brachycephalic skull found at the Chatelperron cave-site dating during the last glaciation, preceding later Aurignacian times.

When two or more ethnic groups meet on different social horizons, there is slow mixture and different reproductive rates, depending upon their natures (warlike or peaceable), amount of wealth, and numbers. Ordinarily, the "lower" groups reproduce faster than the "superior" class and may replace them.

Also, it has ever been since prehistoric time that people who migrate do not represent the physical types of the majority of peoples they leave behind. This can be seen in America today with practically every European national group. The Poles, for instance, in the Middle West are taller, blonder, and more longheaded than the composite of Poland. Colonial "English" showed selection more and more as they moved westward across the Continent.

Ripley's tripartite classification of the races of Europe, Nordic-Alpine-Mediterranean, is a work that has been superseded by elaboration rather than rejection, A. L. Kroeber (1948). No doubt the refined distinctions of Professor C. S. Coon (1939), who recognizes 12 chief racial types among Europeans, six subsidiary types, and three other variants are valid, for the complex migrations must have "hybridized" peoples to a marked extent, although re-emergence among occidental folk everywhere is towards the brachycranial, less blond, less rufous types. On the other hand, the brunet Mediterraneans, like the "Iberians" of Spain and Great Britain, have re-emerged noticeably. In Glasgow, as in the Midlands, re-emergence of old Mediterranean stocks submerged since Neolithic times is noticeable since the Industrial Revolution. The modern Germans are now brachycephalic or nearly so, Saller (1934).

Sweden of Viking times, according to the evidence, showed about five per cent roundheads, now 13 per cent; Denmark, two per cent roundheads, now 33 per cent; Roman Bavaria, 14 per cent, now 83 per cent; early Slavs, nine per cent, now 85 per cent; early Greeks, 10 per cent, now 54 per cent. However, in Neolithic France the range of cephalic indices was 63 to 97. In Belgium in the Ardennes hills lived pure brachycephals with indices over 80. The Neolithic Alpine roundhead may represent an agricultural invasion from the East, mixed with Paleo-

lithic survivors. Certainly they possessed a strong dominance, or "strong genetical survival value."

The problem of re-emergence of an ancient type formerly in the same area has been assumed to mean descent from the former type (even primitive hominids?). There have been some workers in the field who feel that a similar evolutionary tendency existed from the territory complex and acted upon the group for a sufficient length of time. Genetical concepts would call for the genes of the pristine inhabitants to have worked through the genetical screen of the invaders. Latent genes for head shapes and stature show different potentialities under different nutritional and other environmental stimuli.

Physical anthropologists recognize that state of nutrition and state of health make differences in their data and are skeptical of a series measured entirely in hospitals. Again, some variant modern skulls bear a superficial appearance of primitiveness due to pathology of abnormal glandular activity or to extreme cases of normal variation, L. C. Eiseley (1943).

Endocrinologists and medically-trained anthropologists like Sir Arthur Keith believe that the genetical control of the hormones of the pituitary gland may explain man's evolution, so far as morphology is involved. In acromegaly the jaws grow and the muscles of mastication and of the neck expand. Brow ridges are formed, Keith (1926), Lancet, 1, 490. The pituitary gland, which secretes possibly several hormones, when disordered, secretes an excess of pituitrin causing gigantism with bony crests of the skull. Hence, control of this gland by genes and by its nutrilites may be a factor in evolution. Sex hormones and the secretions of the pituitary gland also control physique, as well as some aspects of mentality. This theory, however, has not gained favor. Recent work on the chemistry of oxytocin and vasopressin of the posterior pituitary and nutrilite-hormone interrelationships may revive interest in this theory.

The Mongoloid baby does not grow sufficiently in the eighth to 12th week of its foetal development. Some investigators assert that the psychosomatic state of the mother profoundly influences this entity. On the importance of diet during pregnancy Burke and Stuart (1948) state: "With such strong evidence that good diet during pregnancy lessens the likelihood of complications and contributes to a safer labor and delivery, there would seem to be ample reason for intensive efforts on the part of obstetricians and general practitioners to improve the diets of all pregnant women coming to them for prenatal care. The added evidence that women who have excellent or good diets during pregnancy are much

more likely to have healthy, well-developed infants, and much less likely to have stillborn or prematurely born infants or infants who die in the neonatal period, increases the incentive to improve maternal dietaries." The child is nutritionally nine months old at birth.

France was comparatively densely populated during the Neolithic, except in the Central Massiff or the poverty-stricken area of the Limousin hills of central France. French writers described the area as "*rude et facheux et tout herisse d'epines*" (rude, angry, and torn by thorns). During the Neolithic the Massiff was thinly populated by surviving Paleolithic and Mesolithic hunters and grubbers. The able anthropologist, R. Collignon (1894), found in this infertile area of granitic soils much malnutrition of man and beast, and believed mineral deficiences as well as poverty had combined to produce a short-statured, stricken folk, which now in 1951 we hope is no longer the case. Marett (1936) championed a theory now gaining some favor, suggesting that the most important selection is based upon responses to new types of mineral deficiencies, which may be of profound importance in evolution of races of man and man as a species. The interrelationships of cobalt, iron, phosphorus, and trace elements with vitamins of the B complex (B_{12}) on growth of animals, lend credence to the theory.

The data for Sweden, Denmark, Germany, Switzerland, and France from the Iron Age down to the present show constant increases of brachycephaly (upper limit of dolichocephaly, 76). These changes were not due altogether to racial intrusions or dominant and recessive factors, but to transformation and re-emergence. Environmental, i.e., nutritional influences seem operative. During the Neanderthal epoch the braincase did not expand in volume, but began to change in the direction of round-headedness, probably, as Weidenreich (1946) believes, in connection with adjustment of head to erect posture or spinal balance. Hence, since brachycephaly goes on apace, it may indicate that evolution goes on. Weidenreich warned against using the degree of brachycephalization as a scale to gauge superiority, probably because of the dolicho-cult of green memory. At any rate, as anatomists have known for a long time, the brain may have a brachycephalic shape in a dolicocephalic skull. Weidenreich maintained, and his school maintains, that the great centers of spiritual cultures exist only in brachycephalic countries, forgetting that the same school of thought boasted that the beginnings of civilization should be attributed to the longheaded Mediterranean races, a fact known long ago to the Swede, Oscar Montelius (1899) and to the Dane, Sophus Muller (1905).

A curious fact emerged from the studies of Professor J. Beddoe (1885, 1912) and Dr. R. W. Reid (1926), who measured the remains

of Norman and Norse churchmen of the Middle Ages. Practically all of the church vaults of Norman England show short, roundheaded clergy, while the knights were longheaded, tall warriors. The famous St. Magnus and St. Rognvald, buried in the ancient vaults of the Cathedral at Kirkwall in the Orkneys, were exhumed, measured, and found to be brachycranials. St. Magnus was five feet, seven and a half inches tall, with round skull and receding forehead. The skull shows the mark of the battle-axe which helped Magnus gain martyrdom. St. Rognvald (Ronald) was also of this Alpine type. While brachycephaly cannot be associated with the intellectual, the evidence from the Middle Ages shows strong clerical predilections of roundheads in that turbulent era.

Professor C. S. Coon (1939) believes the Corded, or Battle-Axe, people came up through Holstein to Jutland, the Danish Islands, and finally to Scania. Since they had come from Germany, they were much mixed.

The Borreby race, so named from the site Borreby, Denmark, is found centering in Belgium and Germany. These folk are heavy, tall, moderately brachycephalic, hence the vulgar name "squarehead." In Denmark, the Borreby type is much mixed and is not greatly different from the European Alpine. It is entirely possible that the type or types called Borreby-Alpine-Brunn-Tronder-, etc. were survivors from Paleolithic times, much mixed with later folk. It is not rare in any western nation to see Nordic, Alpine, and Mediterranean types in one family group. The dominance of the Alpine may be genetical, but there is a growing feeling that the brachycephals have become more numerous with each passing century, possibly through nutritional and cerebral stimuli. Condescending folk declared they rather thought these brachycranes were normal. French and Danish anthropologists discerned their worth long ago.

Modern anthropological studies of living Irish, who are the largest group of Celtic speakers but not predominantly representative of this ethnic compost, show these folk to be of Tronder, Hallstatt Iron Age Nordic, and Cro-Magnon-Brunn-Predmost peoples, the latter group furnishing half of their genetic ancestry by re-emergence since Paleolithic or Mesolithic times. Danish, Norman, and British elements are apparent, as well as brunet Mediterranean elements. The Spanish Armada was of no importance in nigrescence.

Over 90 per cent of the Irish have pale, pink skin very susceptible to freckles, and light eyes; three per cent black hair; 40 per cent dark brown; 35 per cent medium brown; five per cent rufous; and the remainder very light blond to golden. There is no ash-blond hair and almost no grey eyes. In all the British and Irish populations the light

skins are prone to redden from weather and often show physiological inability to tan. The nutritional history of these folk indicates they unerringly chose the basic foundation foods for buoyant health when intruders were overcome and assimilated and became *Hiberniores Hibernicis ipis,* "more Irish than the Irish themselves."

The upper social strata of British, especially English, are on the whole blonder, and pattern on the Saxon-Danish-Norman conquerors—the pattern being uniform in the Middle Ages before titles were purchased outright.

It is known that the Southwestern Asiatic cultures spread to several peripheral sections—east to the Indus Valley and west to Egypt. The Asiatic Tasian culture in middle Egypt may be contemporary with either Fifth or Sixth Millennium cultures of Mesopotamia. The wonderful achievements of the Egyptians, albeit they took their time, cannot be minimized, and Egypt became the first nation that had an evolutionary inbreeding, isolated people—a true nation for over 5,000 years. Physical anthropologists find some differences in the Egyptian's makeup since 3300 B.C., although his mind was conquered by the Koran. His "evolutionary" tendency is to revert to the predynastic type of 7,000 years ago! With his unchanging food and state of nutrition, may this reversion be re-emergence? The largeheaded Caucasians settled in the Delta and Lower Egypt before they entered Europe and North Africa. They left their villages at Fayum and Merimde, but they left no anthropological impress on the Egyptian population.

Maps of stature in Europe follow trends of good nutrition, which is apparent statistically. Naturally, the tall survivors from Paleolithic times, Kurgan peoples, Bell beaker, and Megalithic sailors, complicate the nutritional theory, but Mediterranean food producers everywhere are short. However, one must not oversimplify this picture with the comparatively meager data extant. In general, total weight (bulk) seems a function of environment, i.e., climate, food, and drink; excessive bodily volume appears in cool, damp zones, and thin, lightbodied folk in arid or semi-arid zones. Head size is generally correlated with gross bulk and is found in damp, cool zones of Europe, i.e., Teutons and Irish have the largest heads and heaviest bodies, while the desert Mediterraneans are the extreme opposites. The storage of body water is of great nutritional and medical interest, J. P. Peters (1935).

Hunger pangs, pain, fear, and rage are all primitive experiences which man shares with the lower animals from the time of his sub-human antecedents. The effects of these states on bodily changes were studied long ago by Cannon (1920) in the Harvard Physiological Laboratory, and by Dr. G. W. Crile and W. E. Lower (1917) of the Cleveland

Clinic, all of whom observed some remarkable alterations in the body economy and tissues through the emotions which determine man's welfare and preservation.

Nutrition and Stature

Discoveries in nutrition leading to betterment of man's food, where the newer knowledge has been applied, have resulted in marked increase in stature of all racial stocks. This phenomenon has been noticeable in the U. S. A.—a social inheritance—and has led to a nutritional improvement of life, H. C. Sherman and C. L. Sherman (1943). No less an authority than Dr. Franz Boas (1941) found a high relationship between measured intelligence and stature of students. Children short for their age were under the norm in intelligence quotient; those tall for their age were above norm. The close correlation between anatomical and psychological traits in childhood was thought to be due to the influence of tempo of physiological development upon the body and its functions. Dr. Boas did not have data on further development in later life and did not forget heredity as a factor.

An obviously striking environmental trait seen by all anthropologists is stature, which in the past marked many of the socially-favored classes. The rise in stature of all western peoples and Oriental immigrants to North America—Japanese for example—has been amply recorded. We may see in Iceland during its 1,000 years of history that fluctuations in stature follow nutritional and climatic changes and leave no lasting impress on the population.

Among the present-day tall peoples Icelanders, who were derived chiefly from Tronder-Nordic-Borreby groups of Norway, Ireland, and Scotland, shrank in stature during their starvation period in the late Middle Ages to the size of Calabrians, but are now as tall as their ancestors of the Settlement, G. Hannesson (1925), C. S. Coon (1939), and C. E. P. Brooks (1921).

The meat-eating buffalo-hunting Indians of Mid-America, some of the old warriors whom we knew in our boyhood, were often six-footers and heavy like the mammoth hunters of Aurignacian Europe. Race is no doubt important so far as a given genetical pool influences size. The majority of Carthaginians was Semitic, but their nobility was composed of large men with large heads. Other examples of this correlation between size or stature, or size and opportunity, are noticeable wherever there are social and nutritional differences.

During the prehistoric, the early Iron Age, and later historic periods of Greece, the inhabitants were shorter than contemporary Egyptians and Europeans, but in their Golden Age (700 B.C. to 400 B.C.) exceeded in

stature modern environmentally-depressed Europeans. Size increase, rounding out of long bone shafts, lessened incidence of arthritis, and posture changes all followed improvements in nutrition and hygiene, and civilized living. Heredity had far less influence than environment on skeletal change, although the opposite is true of skull changes, J. S. Angel (1946). Good nutrition from balanced dietaries results unquestionably in increased stature and builds with buoyant health. While these changes are thought to be nonevolutionary, we may hint that selection might act on the new phenotypes if they are isolates. Unfortunately, the ever present intrusive groups complicate and probably invalidate the hypothesis. It is difficult to bring something Lamarckian into the concept of genetical drift.

Short-statured peoples are usually found around the Arctic Circle. The Eskimos are short, thickset, and fat covered. Their evaporation loss is small and their diet is largely animal fat and protein. The ancestors of these Mongoloid folk moved into the Holoarctic regions in fairly recent times. The Yakuts who were driven north by Genghis Khan are shorter than their forerunners. The peoples of Finmark (Norway) are shorter than the folk of southern Norway. Most of the Arctic dwellers have been in precarious balance with their food supply. Starvation has proved to be a real force in their selection. Their foods have been exhaustively studied by V. Stefansson (1937) and summarized in his paper on the food of ancient and modern Stone Age man. The prominent nose of the Hither-Asiatic would perish in the Arctic cold, although my friend Roald Amundsen, greatest of Arctic and Antarctic explorers, possessed such a nose, alluded to as "Levantine" by the biographer of the ill-fated explorer, R. F. Scott. A. Cherry-Garrard (1948).

Constitutional Types

The two constitutional types, a hereditary peculiarity of all races, are characterized by tall, slender build, long, narrow faces, and (the other type) stout with short, broad faces. Fortunately, these constitutional types have not confused anthropologists in their fossil finds. G. W. Lasker (1947) observes constitutional traits, and somatotyping (as applied in the Keys Starvation Project where starvation diets led to 24 per cent loss of body weight) to be strongly affected by nutritional status and of little use as a measure of inherited tendencies unless environmental factors are rigidly controlled.

The influence of vitamin B_{12} and cobalt, and interrelationships with other food factors on stature, size, and build is now thought important so far as animal data go. S. E. Synderman *et al.* (1950) call attention to this by stating, "Knowledge of human dietary requirements has been

derived in large part from studies of laboratory animals. However, numerous discrepancies in the requirements of various species are known to exist and in the last analysis, human dietary needs must be established by direct studies in man." Callison, Orent-Keiles, and Makower (1951) also have data indicating that the overall nutritive value of human-type diets for humans cannot be assessed by their effects on rats. In general, the best human diets promoted depositions of fat in the rats and caused higher incidences of body sores and bronchiectasis.

A deficiency syndrome in infants upon prolonged feeding of a purified ration, in which all the vitamins are supplied as synthetic supplements, is characterized by loss of weight, or rather cessation of weight gain, but is not accompanied by any other symptoms or signs. The factor B_{12} may be absent here.

The hilts of swords from tombs of Iron Age Vikings, in the Copenhagen Museum for all to see, show small spaces for hand grasp. The skeletal material consists of remains of tall, lithe men. Numerous queries have arisen for answers to the problem of how such swords could be wielded so effectively (as history teaches) in such small hands. Professor Chester Gould, of the University of Chicago, and the writer, evolved a theory in 1928, invoking mortuary needs for the shrunken hands of the mouldering warrior. However, the living Tuaregs of Berber origin, of the Sahara, are tall men with strong, narrow hands which can easily wield a Viking sword. While skinny peoples are found on hot deserts, they are found elsewhere as well, as any uncritical eye can see in present-day England and other moist environments. The kinds of foods eaten were often thought to be the major influence in developing these types, but statistically, we are told, the influences of climate are the major stimuli, in forming a larger surface area in relation to mass for radiation of heat or cooling surface for evaporation. The same phenomenon is to be observed in deserts. Desert dwellers from circumstance require a concentrated diet.

Blondism

Blondism has been variously associated with genetical and environmental origins for political and sociological purposes. It is a matter of record that Nordic folk (there are very few true Nordics now extant) have never championed the furor begun by Count Arthur Gobineau and terminated by the New Deal. The origin of blondism may be dual—Boreal and Boreal mutants, possibly from the Iranian plateau, who entered the Black Earth regions and Eurasian grasslands sometime during the Neolithic Revolution and retained the advantageous mutation in northern and central Europe.

The early Nordics, because of their greater skill in food producing and weapon making, at first predominated in numbers in their new homeland, but the older food-gathering folk increased, as we can see in the northern physical types who invaded Greece as Dorians and Achaeans, the Italics and Celts, and the Germans and Vikings who came to the Mediterranean lands in succession. These migrants disappeared rapidly even in late classical times, and today anthropologists do not appear to be sufficiently interested in the causes of their extinction to inquire into the fate of these intruders into the South.

The index of nigrescence, or pigmentation, of Europeans follows closely the map of glaciation. Athough the folk of the European glacial area and southern marginal fringes are very complex ethnically (21 variants), they are generally blonder (eye, hair, skin) than people to the south of the area. Many untenable theories have been propounded to explain the mechanisms of de-pigmentation, aside from classic genetics. Certain chemists have invoked the effects of trihydrol from melting snow and ice, soil flora of microorganisms and carbon dioxide, actinic influences,[1] as well as the effects of trace elements. Russian vegetable-oil chemists (notably Ivanov) in the 1920's, postulated that unsaturated fat-acids of fats both in vegetation and animal life, increase as one goes northward, and that unsaturated fats were of great nutritional importance in this respect.

Great changes in climate, resulting in severity for a people over a long period, lead to mutations of persistent value. Certainly, the glacials-interglacials-pluvials-warm-dry-cool-arid changes during the Pleistocene and Holocene had their effects on chromosome or gene changes, resulting in outward somatic changes. The available foods and minerals eaten may have had their effect in these changes, Zeuner (1950). As a rule the melanin pigmentation of mammals tends to increase in warm, wet areas of the species range. Aridity with high temperatures may tend to favor the selection of reddish-yellow pigments, while cold seems over a long period to reduce these pigments. The foodstuffs of these areas varied greatly, but precise data are not available for discussion of genetotrophic aspects of biochemical genetics—a rapidly growing science.

The blue, or light, eye is perhaps native to folk of the glaciated area who have lived there for a long time. The brown eye (chocolate), possessed by the overwhelming majority of humans, is probably a holdover genetically from primitive forms. The influence of nutrition on skin and eye color is not known, but the effect of solar spectrum must have been

[1] Changing degrees of protection from ultraviolet radiations afforded by buffering capacities of the terrestrial ozone shield.

important during the millennia. Light or florid skins facilitate formation of vitamin D from less intense sunlight (D_3 of activated 7-dehydrocholesterol; D_2 activated ergosterol, and nine other sterols, any of which could be activated in the skin by ultraviolet or sunlight). On pages 51-52 and 124 we have indicated the effect of sun time-intensity on formation of important nutrilites in growing plants. Diets from food-producing economies in the old, relatively sunless, glaciated areas of northern Europe and north of the Black and Caspian Seas would need some supplementation of solar D. This could be effected by light skins. Eggs, dairy foods, and marine foods are also good sources of D. Dietary interrelationships, i.e., necessity for most nutrilites including calcium and phosphorus to be ingested daily (before chronic depletion), also depend upon D as well as the other nutrients. Clothing used by Viking Gothonics (Angles, Saxons, Danes, Norse, Goths, etc.) permitted sufficient skin exposure for solar activation of the sterols. The Starkad motive in all heathen Nordic sagas indicates contempt for enervating clothing and luxury diets, and some scholars see the ancient Starkad contempt for dark-skinned thralls to have arisen from weakening malnutrition of these unfortunates in a generally foggy, overcast region, relatively sunless during the Atlantic-Sub-boreal-Sub-Atlantic climatic phases. However, we should not labor this point. There was no lack of sunlight in the Fertile Crescent-Mediterranean areas, and little or no malnutriture from this cause. Nothing at all is known about environmental influences on hair form or color of hair, except perhaps greying and baldness. In glacial times the mammals near the ice walls developed into "woolly" mammoths and rhinoceroses, while the folk who survived donned hides of their prey, much like the habit of Arctic dwellers today. They needed more than fire to survive. Physically they could not be Mediterraneans. Some of them could have been Mongoloids, whose every feature affords protection against severe cold: more or less beardless (the beard is a great nuisance to modern white explorers of the Antipodes, because of retention of exhaled moisture as ice), reduced ratio of surface to volume, adipose padding, good eyeball covering, and accommodating nasal and upper respiratory tract tissues to warm the sucked-in cold air.

When Mongoloids became dwellers in the Asiatic tropics and the large islands the populations with which they mixed changed some of their features, but the rice diet changed them drastically, as it had changed the indigenous folk after Neolithic times.

Hairiness, texture of hair, hair color, eye color, and skin pigmentation, according to Professor A. L. Kroeber (1948), appear to run along hereditary racial lines and to be uninfluenced by age, sex, climate, and nutrition; the epicanthus fold of the Mongolian, the lumbar bluish

Mongolian spot, heavy buttocks, supraorbital ridges, and shovel-shaped incisor teeth all appear hereditary, unaffected by environment. Some biochemists and nutritionists feel otherwise, as obviously does the environmental school, but from lack of concise experimental data the problem cannot be resolved satisfactorily.

Blondism in the tropical zones, as we have seen, is a handicap for survival. The incidence of skin cancers is much higher among fair-skinned, blondish people in the United States, especially in the sunny South. Blondism is concomitant with survival in the cool, foggy centers, where blonds do occur in greatest numbers. The darker folk of the Tundra and Arctic lacked the mutation tendency for blondism, but they have not resided there long. The recessive genes or traits in the Paleolithic peoples of Europe may, during the long millennia, have induced this tendency for survival. The problem of the flesh-eating European *vs.* the cereal and vegetable oil-eating brunet folk has never been studied nutritionally.

Seasonal changes in hair of weasel and hare do not apply to humans, although there are theories extant which ignore genetical concepts and postulate epoch-long influences on pigmentation, resulting from food-mineral stimuli, selection, and "Russian evolutionary concepts." Blondism, or partial lack of melanin, can sometimes be controlled in experiments with laboratory animals by copper deficiencies, vitamins, and essential nutrients, hydroquinone, and other stimuli. Red hair, the pigment of which is related to melanin, is associated with blondism and has often been ascribed to Paleolithic peoples and Paleolithic survivors. It may be an independent variable, not associated with either blondism or nigrescence, and not associated with eye color, except in Scandinavia and Ireland. All through the Middle Ages red-haired wet-nurses were not in demand—their milk was thought to be acrid! Golden hair contains rufous elements. Rufosity in U. S. A. was found at the turn of the century in greatest percentages among the Irish, Danes, Scots, Kazars, and Anglo-Danish, North Germans, and Normans, where the old Paleolithic hunters left their mark. Neel (1943) observed that all red-headedness does not have the same genetic basis and is not determined by a single completely dominant or recessive factor. Red hair contains more iron and more ash than hair of any other shade. There is no relationship between copper content and human hair color, Dutcher and Rothman (1951). In case of animals, however, achromotrichia or depigmentation of hair involves copper deficiencies. Copper is likewise involved in the normal process of pigmentation (melanin pigments), Marston (1952), McElroy and Glass (1950).

Hair color is considered to result from the presence of two kinds of pigments, granular melanin and a diffused red-gold pigment which are probably genetically independent of each other. Lack of melanin and the red-gold pigment results in ash blondism. Black hair depends upon amount of melanin. Presence of the red-gold pigment results in the various shades of red hair and yellow blond hair, and together with melanin, shows the red glints observed in more nigrescent populations. The maximum depth of pigmentation is found in hot climates, the minimum in north and northwest Europe.

Longevity and Nutrition

It may be gratuitous to mention again that longevity is not an index of progress if we do not live better. The profound effect of nutrition and the partial conquest of disease have increased life expectancy greatly, ushering in new complex problems for the State and for medical science. The unprecedented increase of population has challenged the food technologist, nutritionist, and geneticist in respect to food supply, but we believe hopefully with Sir E. John Russell (1950) that the last word has not been said in regard to food production.

The age of a man can be determined within certain limits by osteological characters, hence survival curves can be constructed for fossil man. If age in years at death is plotted against survival per 1,000 born, the Neanderthal shows a sharp drop at 20 years, while Mesolithic and upper Paleolithic men show increased survival (to 25 years), but comparable death curves afterwards.

The vicissitudes of the Mesolithic forest peoples of northern Europe are reflected by higher mortality rates and a lower mean life-span, as compared with upper Paleolithic folk who preceded them. Life-span generally, as seen in Senyurek's (1947) figures for the Copper Age to Roman-Byzantine times in Anatolia, increased with progress of civilization.

Low rates of infant and juvenile mortality among some primitive races have been ascribed to long lactation, and coitus taboos during lactation.

Some theories and data, notably those of Eva Jalavisto of Helsinki, Finland, show that offspring of young mothers (24 years or younger) tend to live longer than those of older mothers (40 years or over). There was no correlation between longevity and the age of fathers. The average prehistoric man lived a relatively short life in comparison to modern man, and his chance to survive 40 years was relatively remote. Death by violence was common. Many fossil skulls show heavy blows.

Age upon death in the historical period, as shown in burial inscriptions, may lead to faulty conclusions because (a) not all burials of a community were made in cemetery (there were battle deaths, death at sea, etc.), (b) younger persons leaving a community left older people behind and so the ages at demise were high. New settlements of younger age groups likewise present the picture of lower age at death.

Greek skulls, 3500 B.C. to 1300 A.D., show a slow rise in longevity of man, sturdier and larger skeletons, reduction in arthritis, and improved teeth. This may be owing to entry of other, larger races from the north, better living conditions, better nutrition, and the rise of Greek medicine, J. L. Angel (1947). A total of 384 Greek crania, covering 4,000 years between 3500 B. C. and 1309 A.D., divided into eight periods, was studied by Angel. Estimates of mean age at death were made on the basis of closure of cranial sutures. (Neolithic-Early Bronze, 3500-2000 B.C. = 31.8 years to Roman, 150 B.C. to 450 A.D. = 38.5 years). The data are too scanty to determine exact life expectancy.

A life table prepared from Ancient Greek burial inscriptions about 400 B.C. shows an expectancy of 30 years, Karl Pearson (1901). A study of Egyptian mummy cases shows survivals from ages 10 to 68. MacDowell (1913), in his study of expectations of life in Ancient Rome and the provinces of Hispania, Lusitania, and Africa, worked out a compilation giving age at death of several thousand Roman citizens of the early Christian era: The city of Rome, 20 years; Hispania, 35 years; Lusitania, 35 years; Africa, 45 years (compared with the U.S.A. of 1900, 46 years). J. C. Russell (1948) determined life expectancies of Medieval England as: 1276 A.D., 35.28 years at birth; 1426 to 1450 A.D., 33 years; in Europe about 1550 A.D., 30 years; England of 1780, 38.72 years; U.S.A., in 1790, 40 years; 1854, 41 years; 1900, 49 years; and 1946, 66.7 years.

Compilations from all sources show longevity in percentage dead from middle Pleistocene to the 20th Century to be

LONGEVITY IN PERCENTAGE DEAD

	Age in years				
	0-14	14-20	21-40	41-60	60
Middle Paleolithic, pct	40.0	15.0	40.0	5.0	—
Upper Paleolithic, pct	24.5	9.8	53.9	11.8	—
Mesolithic, pct	30.8	6.2	58.5	3.0	1.5
Bronze Age, pct	7.9	17.2	39.9	28.6	7.3
19th Century Austria, pct	50.7	3.3	12.1	12.8	21.0
20th Century Austria, pct	15.4	2.7	11.9	22.6	47.4

Sir Arthur Keith reckons the total population of the earth in mid-Pleistocene times at 4.2 millions. In 1951 the world's population approached 2.5 billions. W. S. Thompson (1950) believes that Malthus was fundamentally correct when he said that population increases depended upon food supply, but other aspects of population growth and change, while secondary yet vitally affecting the peace of the world, are distribution of population, qualities of people, migrations, changes in age structure, differential birth rates, and the control of death rates. Sheer lack of food, not of proper foods, is the curse of the Oriental economy.

The degenerative diseases, the present greatest challenges to medical science, are by no means restricted to old age. Dr. Ancel Keys (1948) believes that mode of life is a major factor, if not the basic etiology. In the occidental industrialized nations life expectation at birth has been steadily lengthened, but there has been no comparable gain in life expectation of the adult. Obviously, the newer knowledge of nutrition has not been put into practice until recently, and as someone has said, proper nutrition should begin with conception and terminate with resurrection (depending, of course, upon terminal supramundane considerations).

CHAPTER XIV

Climatic Stress and Nutrition

Cold Environments

In reading this chapter we may keep in mind the climatic stresses experienced by food-gathering man and his available food supply, described in Part I of this book.

Mitchell and Edman (1949), in their studies on nutrition and climatic stress, concluded that in a cold environment, in proportion to its severity, active man needs definite increases in his caloric requirements. They observed a high carbohydrate-fat diet is superior to high protein intake, but high-fat meals are superior to high-carbohydrate rations in maintaining tissue temperatures. It is suggested that this is related to heat emission rather than heat production, and may involve a temporary deposition of dietary fat in the subnormal tissue following a high-fat meal. The insulation effects of a layer of fat under the skin are obvious. A very favorable effect on resisting cold is produced by increasing the number of meals and decreasing the intervals between them. The vitamin requirements (riboflavin, niacin, and ascorbic acid) furnished by freshly killed meat are very important. There is marked impairment of muscular endurance in deficiency (in low intake of one or more of these three vitamins), but in full daily allowance there is no favorable effect on maintaining thermal balance, psychomotor or intellectual performance. There are indications that true acclimatization to the cold does occur. The high fat-protein diets of the Eskimo may be largely due to the unavailability of carbohydrate foods during most of the year. At any rate, men, if they have selection of food, acquire food habits best adapted to aid them in combating climatic stress; which supplements clothing to some extent. The physiological response to cold stimulus results in increasing the metabolic rate through voluntary or involuntary action and in decreasing heat loss from the body surface through postural and vasomotor adjustments. Visual powers are not decreased through continuous exposure to cold, but dexterity is diminished. Muscular fatigue and undernourishment, i.e., nutritional anemia, impair resistance to cold. Roald Amundsen informed the writer that the polar climates engendered in his Norse comrades a great craving for fats, carbohydrates, and fatty meat.

The Specific Dynamic Action (SDA) of Foods

The Specific Dynamic Action (SDA) of foods, or extra heat produced by fatty foods, carbohydrates, and proteins, has been under ob-

servation for a half-century, but recently the trend of thought has been to regard SDA as wastage of food energy. In cold, SDA does increase tolerance, as well as exerts a sparing action on body tissues. The best foods for cold tolerance are high carbohydrate-fat foods, with a protein supplement for the essential nutrilites. High protein diets, due to their high SDA, are of benefit to the arctic dweller during inactivity. In truth, much of the newer data on foods and climatic stress do not fit well into the old "preconceived" ideas of the Arctic dwellers themselves!

Long ago, Lavoisier noted that ingestion of food increases heat production, i.e., raises metabolism above the basal level (SDA). Body heat begins to rise one-half hour after ingestion, a maximum in three hours, and this level is maintained for from three to five hours. The most pronounced SDA is produced by protein food. Comparative studies show proteins cause 30 per cent or higher rise above basal level, carbohydrates, six per cent, and fat four per cent; i.e., if a test animal whose basal metabolism is 100 calories daily is fed protein-carbohydrate-fat separately in a diet of 100 calories per day, the heat production will be 130, 106, and 104. The actual heat arises from burning of body tissues, hence the losses of weight can be prevented by supplying 130 calories if the diet is protein, less if carbohydrates or fats. The heat cannot be converted to energy or work. It is "waste heat" to dwellers in warm offices. The chemical regulation of body temperature (heat production) is outside the province or scope of this discussion.

At high environmental temperatures, the SDA of foods impedes physical mechanisms which hasten heat loss; hence, a low protein diet is more suitable in hot weather (Egypt, Fertile Crescent). At very low environmental temperatures, SDA is quite marked because it replaces enviromental effect (cold). Protein foods in cold climates are of invaluable aid to chemical regulation of body temperature. Fat and carbohydrates, however, produce heat that can be directed towards the performance of work. The SDA effect of protein depends upon six or more of these amino acids: glycine, alanine, leucine, glutamic acid, tyrosine, phenyl-alanine, and the reactions responsible are probably situated in the liver. With carbohydrate foods, energy is liberated in excess required for conversion of glucose to glycogen.

One gram fat .... yields 9.3 calories
One gram carbohydrate .... yields 4.1 calories
One gram protein .... yields 4.1 calories

Animal protein is slightly higher than vegetable protein; hence, in a mixed diet values are taken at four calories.

Nitrogen Balance

The healthy adult requires protein to replace the inevitable loss of tissue protein through repair of wear and tear. In starvation, or on a low protein intake, the body continues to excrete nitrogen from breakdown of its own tissues, or protoplasm, and "goes into negative balance." In children, pregnant women, or adults building up from wasting disease or muscular exercises, the body tends to keep more protein for manufacture of new tissue. In order for the body to retain suitable amino acids, a large assortment of protein must be available or the nonessential protein is discarded. For this reason, a smaller amount of protein, like beef muscle, containing the essential amino acids can be eaten for building, rather than larger amounts of inferior vegetable proteins.

For instance:

Lean meat is complete protein

Milk is complete protein

Wheats are partially complete (gliadin lacks lysine; glutenin is complete)

Corn is incomplete, lacks lysine and tryptophane; low in cystine

Eggs are complete protein

The quantity of protein to establish nitrogen balance also depends upon fats and carbohydrates. It is impossible to establish nitrogen balance solely on a protein diet, because modern man cannot digest enough protein for his energy requirements but must draw on fats and carbohydrates. He would need eight pounds of meat to keep nitrogen equilibrium. Primitive men like Eskimos can consume enormous amounts of meat but also conserve fats and glycogen with it. On a mixed diet, nitrogen equilibrium can be established on a low protein intake. Carbohydrates and fats are protein sparers but fat, when fed alone, has little or no protein-sparing action, while carbohydrates alone show a marked effect.

Some recent data suggest that to promote efficient utilization of the nitrogen of an amino acid mixture at least 20 per cent of the nitrogen should be in a form other than that of the essential amino acids.

We have observed from time to time a condition in workmen in the fresh beef departments of meat packing plants, who habitually eat small pieces of raw lean beef. Their red cell blood counts may approach eight to nine million cells per cm. The norm for men is usually about five million. These polycythemias were undoubtedly present in primal man subsisting on uncooked or rare red meats. In white men a florid

complexion often attends polycythemia from this stimulus, but naturally all florid complexions are not due to this cause.

S. Irmak (1938), in his study of diet and balance of the nomads of Asia Minor, found these folk to have the finest visual acuity of peoples heretofore reported. The finest vision was observed in males 10 to 38 years old (nine-fold acuity) and even in old age he observed three-fold acuity. Those with unusual vision also surpassed others physically and intellectually. The Nomads themselves believed their acuity depended upon eating meat, but Irmak believes these fine visual acuities indicated hereditary dominance.

Variable Temperatures

Heat and cold in alternation have a very much greater effect than has either one when continued for some time without change. Polar explorers like Nansen, Ross, Stefansson, and Amundsen remarked about the "insufferable" heat of 26°F. after months of —47 to —15°F. A temperature of —20°F. was "comfortable." Medical climatologists have much to say about physiological and mental reactions brought about by climatic influences. The many studies of Ellsworth Huntington on civilization and climate have broadened our concepts of these fundamental relationships between climatic stimuli, ethnic cultures, and "efficiency." Variable climates in which meteorological conditions vary extensively from day to day are as unfavorable as are constant temperatures. Misconduct in humans may be more prevalent under certain conditions of weather that heighten alertness and energy, although a theologian would invoke other stimuli for misbehavior. Certainly, many of the partially blond folk of the North do not fare well, nor do they survive as a group, in tropical lands. Likewise, as Forde (1949) points out, the bracing climate of the stormy westerly zone, to which the vigor of west Europeans has so often been attributed, failed to stimulate any important development of Tasmanian or Fugean cultures.

The ethnic composts which we call *Homo sapiens* are not essentially different structurally and do not differ much from their remote progenitors whose environment was that of the lower animals. With the advent of food production and the Urban Revolution, "men of learning," wrote Celsus in the First Century A.D., "and almost all dwellers in large cities suffer with their stomachs." There has been little change in this respect for the past 2,000 years. Whether or not man's environment as he now has fashioned it is best suited for his body, it is quite evident that he has been obedient to the pursuit of comfort and fashion-fads. We may change a bad atmosphere, which consists ordinarily of heat, humid-

ity, and stillness, to coolness, dryness, and motion. We may change our clothing, air temperatures, homes, and environment at will (if we have the funds), but our bodies, minds, and temperaments change only by the slow evolutionary process, activated to some extent by proper nutrition.

With man's new machines he transports himself so rapidly that when taking off on a desert airstrip the temperature may be 135°F. and within a short time be at –65°F. These extreme impacts have obviously never before confronted man.

The ghosts of environmental diseases, both nutritional and contagious, have been laid in scientific books but not in fact. Much work has been done on the effects of diet on tolerance to high altitudes. It appears evident that high carbohydrate diets are of considerable value so far as flyers are concerned, but the overall picture of long racial residence in high altitudes shows there are changes in the respiratory apparatus, blood chemistry, pigmentation, stature, bulk, and posture.

Response to alterations of the complex elements of the biosphere, with nutrition a major factor, has profoundly affected man. Since it is obvious to some that "pre-human" ancestors of man lived in warm climates and were hirsute, it follows that the use of fire, and skin clothing, made it possible for Dartians and other hominids to change environments with concomitant change of foods, thus to become variable in appearance.

The effects on health of cavern and cave habitations which man had used for a half-million years are known only by conjecture, but Hosse (1948) finds the climate of caverns favorable for patients affected with asthmatic or catarrhal diseases. Paleopathological studies of bones, however, do picture early man afflicted with a host of diseases. Kleitman (1949), in his classic work on biological rhythms and cycles, observed seasonal periodicities related to variations in light, temperature, and humidity. Pulse rates increased the first month of winter and were low in summer. For instance, at mean daily air temperatures of 60 to 64°F. the body temperature was 97.98°F. and pulse 79.4. With air temperatures of 85 to 89°F., body temperature was 98.32°F. and pulse 86.3. Basal metabolism rates tended to lower in winter and spring and were higher in summer and fall. The rate of growth of boys increased about 90 per cent from June to December. In this connection, Dr. L. T. Webster of the Rockefeller Institute, observed that survival rates from infectious disease, and from toxic materials injected in carefully measured doses into mammals, were highest in midsummer and lowest at one point in autumn and in early spring at the latitude of New York. Our work at the Mayo Clinic, Rosenow and Jensen (1933), on 650 rabbits

injected with certain bacteria over a period of six years, showed substantially these same seasonal variations in mortality. Nutritional knowledge of those times, however, left much to be desired in evaluating the data. It is now our opinion that controlled diets in experimental animals and the room temperatures in which they are housed may have much to do with survival rates.

Diet, Disease, and Immunity

Dr. Paul R. Cannon (1942, 1943, 1945), through both animal experimentation and clinical observations, has shown the necessity of an adequate protein diet in order that certain of the body tissues can produce globulins—the stuff antibodies are made of. These fighting forces against infectious disease depend upon the protein intake. He has shown that owing to mass starvation in wars, impairments due to age, combined with deficiency of protein intake and other circumstances, the host loses the ability to react successfully to types of infection which otherwise might have been borne well. In marked protein deficiency there is both clinical and experimental evidence showing that high-quality proteins are needed in the diet, to restore depleted tissues and promote effective functioning of bone marrow and other phagocytic cells which engulf and digest bacteria, as well as to maintain and extend the effectiveness of the antibody mechanism. Immune substances (antibodies) are serum globulins, and their synthesis depends upon diet. Dr. Cannon's work has indicated the basic importance of protein metabolism in relation to natural and acquired resistance, and points up again the fact that many important aspects of infection and resistance are nutritional.

It takes a bit of doing to align nutritional immunity as a gene-governed trait. Burnet and Fenner (1948) have discussed the problems of immunology relating to cytoplasmic genetics. It appears that antibody production may be regarded as a property of self-propagating cytoplasmic determinants. On the other hand, nutrition appears as a very uncertain factor in explaining the low incidence or absence of rheumatic fever and clinical diphtheria in the tropics. Dr. A. F. Coburn (1931) points out that rheumatic fever is uncommon to inhabitants of Porto Rico. The Porto Ricans who came to New York not uncommonly acquired the disease, while their children in the active rheumatic state, when removed to Porto Rico quickly recovered, only to relapse again when they returned to New York City. Though clinical diphtheria is infrequent in the tropical zones, diphtheria bacilli carriers seem just as common in India, for instance, as in the temperate zone, R. T. Hewlett (1930). Other diseases, like poliomyelitis and streptococcal infections, may also follow this pattern.

Natural selection of immunes over long periods of time may account for some of the low case-rates of certain diseases of the tropical and subtropical zones. With the coming of the Neolithic and Urban Revolutions the susceptibles among early populations of the Fertile Crescent, including the Indus, were weeded out. The more lethal strains of microorganisms kill their hosts and tend to become eliminated. Immunity gradually develops which favors the survival of the less virulent microorganisms. Marginal cultures of Europe and Asia were not exposed as early in point of time, but northern European and Asiatic folk had not and have not the immunity to many diseases which tropical zones have rendered less malignant. Some of the northern folk develop their diseases in the tropics as well. Isolates of long standing, like the folk of the Pacific Islands or Amerinds of Colonial times, succumbed to new diseases which were not especially malignant for Europeans. Neither the Europeans, Egyptians, nor Asiatics resisted bubonic plague. The problem of virulence and resistance, upon which so much labor and learning have been lavished, certainly presents a facet of nutrition. Athough much remains to be learned, enough is known to realize that urban life is not old as pre-history and history go, and that selection of human types has taken place on the basis of infection. Malaria, for example, as a maker of history, has exerted a profound influence on the rise and fall of cultures. We mention the Island of Cyprus in this connection, where through the historical period malaria exerted its destructive effects. Today the Cypriots themselves are actually exterminating malarial mosquitoes with DDT in gammexane smoke for high buildings and places of difficult accessibility, in their mountainous country and snake-infested caves. The Egyptian fly, a serious pest for long ages, still causing the death of 40 per cent of Egyptian babies dying before the age of five, gambols around happily in gammexane-DDT smoke and chlordane.

Food-gathering folk, few in number and living in families, may not have come in contact with more than a thousand people in a lifetime. This aspect of epidemiology of man has not been sufficiently stressed. Man in his various forms lived for a half-million years before the *augenblick* of historical time. Neolithic villages like Fayum, Merimde, or elsewhere brought more men into proximity, and with the development of towns and cities, the chance for infection (as Dr. L. T. Webster's and Topley and Wilson's classical studies have shown) grew correspondingly. Traders of the caravans kept diseases smoldering from the Nile to the Indus, as well as did newcomers—slaves or war captives—to the rapidly growing cities, now tells and mounds these thousand years past.

Just as a spot-map of active cases of tuberculosis showed clear-cut areas correlating with national origins in our cities of 1860 to 1930, so the new environment of the compact hovel-cities in which the first "new masses" were crowding along the Indus, Tigris-Euphrates, and Nile exacted its great selection. The sewage cycle of filth disease, Bilharzia, J. Bernstein (1947), hookworm and other worms, cholera, typhoid, bacillary and amebic dysentery, respiratory diseases, venereal diseases from the great reservoirs of temples and other brothels, all conceivably screened man profoundly.

The surviving types of Mediterranean folk from India to North Africa are quite resistant to local diseases so far as mortality rates are concerned, but morbidity rates are very high. The stasis of the "unchanging East" may have been a result of these factors. Their basic food pattern, which resulted from their discovery of food production, presented every nutrilite of the Basic Seven Foods (wheat, barley, unpolished rice, most vegetables and fruits, oil, meat, dairy foods, fish, and fowl) for vigorous mental life. As history unfolds their daily life, it appears often that the mass of uninfluential folk subsisted on minimum amounts of food without much variety of food items. Urban selection has gone on and is still going on apace with a train of pathological traits and selection for survival, which when viewed either from phenotype or genotype alteration is characteristic in its effects, both in the Oriental and Occidental worlds. When Oliver Wendell Holmes wrote, "We are the omnibuses on which all our ancestors ride," he did not include all of them. As an example, F. G. Parsons (1910), in his measurements of skulls in a church crypt near Kettering, Northhamptonshire, the heart of the Anglo-Danish settlements, found the 14th-15th-Century skulls and bones bearing little resemblance to Northerners but good resemblance to Celtic Iron Age invaders. The Great Plague of 1666 A.D., with "Forever Amber" pits of Whitechapel, Moorfields, and Farringdon Street, all show Iron Age Celtics, ancestral to the modern cockney. The English populations of North America up to the final settlement in the West were apparently not preponderantly of these groups, as Sir Francis Cohen Palgrave (1861-1864) noted.

Dental decay and diseases of degeneration and mineral imbalances are relatively commonplace in the skeletal remains of man, from the lower Paleolithic on to present times. Man has never escaped arthritis; nor did the dinosaurs. Neanderthalians were plagued with the disease, as were the *sapiens* men who followed and who absorbed some of them. Tooth decay has always been rampant, and infections of the mastoid process are known to have existed in lower Paleolithic times. Bone tuberculosis

is evident in Neolithic Europe as well as in pre-Columbian America. Rickets resulting from vitamin D deficiency is seen in Neolithic skeletons of Sweden, and the great pathologist Virchow thought he saw rickets in Java man and Neanderthalians. Endocrine diseases of several types (acromegaly, Paget's disease), disturbing bone growth and causing congenital abnormalities, are seen in some fossils and demonstrate early man's susceptibility to disease. Dr. W. M. Krogman (1940, 1949), in his enlightening studies of the record of human illness, has shown that prehistoric man had his share of infections, nutritional diseases, and bone-breaks. Many of the present-day ailments are ancient, indeed.

Microbial and especially parasitic diseases are very prevalent in wild primates, and were undoubtedly present in prehistoric man as in primal man of later times. With the rise of medicine and reduction of infant mortality rates, civilized man began to multiply at previously unheard of rates. His nutrition where good has increased his simian behavioristic qualities, but has influenced to a greater and more laudable extent his humanistic qualities.

No doubt many groups of animals, and perhaps man, became extinct through epidemics and disease. Rickets and arteriosclerosis do not appear until food-producing times or the earlier Neolithic times of the South; whereas, in the far north of Europe many undated prehistoric skeletons show the solar and nutritional deficiencies which lead to rickets. Focal infection from teeth was treated by an Eighth Century B.C. Mesopotamian physician who wrote "The inflammation wherewith his head, his arms, legs, hands and feet are inflamed is due to his teeth. His teeth must be drawn: it is on this account that he is inflamed; he will reduce it through internal channels. Then all will be well." B. W. Weinberger (1941).

There are two forms of dental caries, Bay (1942), in prehistoric teeth. The real caries, then as now, favors the fixed apices, neck, fissures, and contact surfaces of teeth. False caries is due to post-mortem action by bacteria, humic acids, and breakage, and occurs without fixed location, anywhere on the surface of the root and in the enamel.

There was little or no rickets among the early Egyptians in their sunny environment, which seems to be proven from examination of their medical papyri, records, and osteological remains. There is a reference to night blindness and xerophthalmia in Egypt of 1500 B. C., and a reference to the effect of eating liver as a cure for these afflictions. Rickets was not prevalent in Athens, but was noted in Rome from 200 A.D. to the present. Iron Age Vikings in their relatively sunless environment used cod-liver oil for rickets as well as other diseases. They used pine-

needle and spruce tea for scurvy and there is evidence they brought some of their treatments with them to Scotland, England, and Normandy.

There are 91 diseases known to be transmitted from animals to man, T. G. Hull (1947). The cow carries 29, hog 15, sheep and goat 18, dog 33, cat 16, fowl and birds 19, and bats, mice, and rats, 20! Rabies carried by bats no doubt plagued men in their caves and caverns.

There are high blood-pressure peoples; others, like the Eskimo, are free from hypertension. There are neurasthenic types, most of the group actually psychopathic by our standards, yet they fish and hunt with success in their environment, to which they have reacted with fixed patterns. Slight changes in their environment, however, cause their destruction. Yet with all the handicaps of disease, disaster, and starvation, the world population in 1949 was estimated by Sir John Russell to be 2,300,000,000, and increasing by 20 millions each year!

It is commonly conceded that constituents of the diet may be the cause of various types of allergic disease. The Roman Lucretius (99-55 B.C.) in his great epic "On the Nature of Things," reconstructs the life of man not very different from the modern ideas of the development of culture. He recognized allergy by his statement, "One man's meat is another man's poison." In clinical practice cases of asthma, colitis, dermatitis, hemorrhages into the skin, and rhinitis, due to food, are observed. Elimination of offending foods, however, may lead to detriment of general health and to a state of malnutrition. Since purified nutrilites could not be used in the past, allergies must have caused a great deal of illness. Dr. A. F. Coca (1943) in a study of familial food allergy shows the debilitating effects of allergy and how allergies aggravate diseases of heart, brain, and intestinal tract. Food allergies of a small inbred group could lead to their extinction or cause them to migrate, A. H. Rowe (1932, 1947). The manifestations of allergy are as ancient as man himself, W. T. Vaughan (1939), and are global in distribution but of unequal intensity in the several continents. The condition occurs in animals, as all veterinarians have known for a long time. Cattle have "hay fever" and cats and dogs have food eczemas. About 10 per cent of the population of the U. S. A. has frank allergies and an additional 50 per cent shows some minor allergic manifestation at one time or another.

Most students of allergy believe there is a positive family history in 60 to 70 per cent of allergic patients, but that all individuals may be afflicted with mild or transient allergies. There can be no doubt, as Ratner emphasized, that allergy may arise through the chromosomes according to Mendelian laws and *in utero*. The interest in allergy here is

that small inbred groups of those far-off times, as now, developed taboos for foods and from necessity avoided, if they could, certain environments and foods that made them ill. Food allergy today is recognized as a frequent cause of a large variety of symptoms in humans. Either a single food or a large number of foods, both vegetable and animal in origin, especially in the young and sometimes throughout life, are allergens responsible for distressing traits of mind and weakening of physical powers. The subject of clinical allergy, too voluminous to be dealt with here in its numerous clinical manifestations, demonstrates that small familial groups of pre-history may have died out in their toxic environment, or migrated to new environments if they could. Allergists today believe much allergy arose when wheat, milk, and eggs became common foods. In short, all foods and condiments may cause allergy, but the foods eaten in largest amounts, as would be expected, are the most frequent causes.

"Natural selection" of man, especially in severe allergy, is seen often by clinicians. However, residence in warm, dry climates is believed by physicians to influence favorably most types of allergy. With few exceptions all authorities concur on the influence of heredity as a strong predisposing factor in the development of allergy. When there is bilateral family history, 65 per cent of the offspring are allergic; with unilateral family history, 35 per cent of the descendants are allergic, Rinkel, Randolph, and Zeller (1951).

Sunlight

Sir Arthur Keith recognized the evil effects of tropical actinic rays upon northern migrants and saw the influence of skin nigrescence in protection. If white skin is a foetal inheritance, then the effect of light on the human organisms is probably of importance in causing ethnic variations. The compost of peoples who lived and now live on glacial territory of Pleistocene Europe is less deeply pigmented than the "non-Nordic" folk of the earth. The light intensity of the African desert is over 200 times that of the Baltic and German seacoasts. Blue-eyed, blondish persons with fair skins, especially those with blue-eyed parents, are more susceptible to carcinogenic effects of solar rays than brown-eyed persons. The more "brown"-eyed inheritance one has, the less susceptibility to sun-induced skin cancer is observed. The data now accumulating in the U.S.A. show this North-South effect after a relatively short sojourn of Europeans in the New World! A selection of over 10,000 years in Europe is unmistakable in effects on coloring. Even the Normans of the Two Sicilies noted the effect in three generations

in their new home. Today a light eye among these folk is called "Norman eye."

M. Weninger (1949) asks the question, Can race-characters be pathological? His own answer is that man, as well as domesticated animals, may be liable to reproduction of pathological mutations owing to domestication. Characters useful in their country of origin when transferred to other biotypes may, though not pathological in themselves, lead to weakness. Blond skin is not suitable for the equator; prominent noses to prewarm air are not good in the tropics, while the negrids in the North, lacking this characteristic, are predisposed to pneumonia and respiratory diseases. The Eskimo and Mongoloids of the Arctic regions seem to do well and Dr. W. A. Thomas observed numerous negroid Eskimo, resulting from an American polar expedition, to be suitably acclimatized, and successful food gatherers. The brown eyes possessed by most humans are inherited from our primate ancestors. Brown- and chocolate-colored eyes are alleged to have greater resolving power for the hunter, but enough is known about U.S.A. marksmen to doubt superiority of brown over blue-grey eyes. Proper foods, or the Basic Seven Foods, have more to do with acuity of the normal eye than color of the iris.

In America and elsewhere there exists a widespread belief in the beneficial effects of sunlight, which finds expression in the current fad of sun-bathing. Dr. H. F. Blum (1943, 1945) believes too much has been written about the dire effects of tropical sunlight, and it would be unwise to revive the wearing of red spine-pads or other paraphernalia designed to combat dangers that do not exist! While G. Price (1939) shows clearly that dark-skinned folk supplant the white man in the tropics, Blum believes that direct effects of sunlight have no influence, and that degeneration of whites in the tropics may or may not be ascribed to prolonged effects of constant hot environment, the physiology of which is not clearly known. Sunburn of the cornea and conjunctiva may cause disturbances of vision. This condition also occurs in the frozen North as snow blindness.

There have been many theories proposed to account for the distribution of blond characteristics. Since all of these speculations are to be found in sober texts, may we not add another theory, one invoking nutrition? Two shiploads of Norse emigrants of Tronder type from the same area, leaving for North America in the 1830's, quarrelled about their destination, one shipload leaving for and settling in the Rio Grande valley; the other group in the old Northwest of Illinois-Wisconsin. Flom, Anderson, Holand, and others traced their subsequent history and found in 1920 that the southern group had nearly disappeared, the

survivors were generally a weak lot, there was high incidence of nervous and skin diseases, and that they were poor, whether in jail or free. On the other hand, the group in the Illinois-Wisconsin-Minnesota area had increased tremendously in numbers and wealth, furnishing excellent citizens for their new country. Huntington and other students of environment have also dwelt at length on this clear-cut effect of environment. Our own inquiries suggested that diets were an important factor. The oat-wheat-barley-rye cereals supplemented largely with beef, fish, and dairy foods were the familiar diets of the northern settlers; whereas, on the Mexican border of those days a restricted diet of maize, beans, peppers, some game, and salt pork were their staple foods.

The Loyalists who left the United States in Revolutionary times and settled in Ontario and the Bahamas, show great strength in Canada, contrasted with opposite characteristics in the Islands.

The Historical Greenland Question

The colonies of Erik the Red in Greenland were established 985 A.D. to the west of Cape Farewell, since the east coast is ice-locked for most of the year. The western littoral is a maze of bights and islands, but on the lower margins of the fiords there is plenty of grass and carpets of flowers in summer, and bocage of small birch and willows. The food supply consisted of beef, fowl, eggs, salmon in the rivers, walrus, sea-fish, seal, reindeer, rabbits or hares, bears, foxes; later some barley, berries, sheep, goats, pigs, horses in goodly number, cheese and butter, but no wheat. The poorer classes, according to the "King's Mirror," had never tasted bread, but the sagas state that a little wheat was imported from time to time during the "ship days." They utilized iron ore bogs for iron, soapstone for utensils, skins of bears, seals, and otters, walrus tusks, and blubber, and they captured white falcons for the Vatican and European nobility. The Eastern Settlement numbered 200 homesteads, 12 churches, and two monasteries. The Western Settlement numbered 100 homesteads, four churches, and in all, 3,000 souls. In summer, hunters always went north, far into Baffin Bay and beyond latitude 72° 55′, where in 1824 was found a runestone dated April 25, 1300 A.D. At Gardar a cathedral was built, ruins of which can be seen today. Close connections with the Pope were maintained (Peter's pence). The Hanseatic league eventually isolated the colonists. The northern kings and merchant "princes" monopolized their trade. At last forgotten by the civilized world, these poor folk knew themselves doomed, for after the last European ship (1410 A.D. from Bergen) they waited a century for another. In 1550 a German merchant ship blown off its course, sent

a landing-party who found Eskimos, and a Norseman—the last of Erik the Red's colonists—lying dead clothed in a hood, coarse woolen suit, and seal skin. At his side lay an iron knife almost worn away by long use and sharpening.

The Vatican records aid us much in learning their history. In 1345 the Pope ordered that they be excused from tithe. The last Bishop, Alf, died in 1377. In 1492, Pope Alexander VI in a letter declared that the Greenlanders lived on dried fish and milk and that he knew of no ship now for 80 years that had visited them. Most of them had abandoned Christianity and had nothing else to remind them of their faith but an altar cloth (corporale) which was exhibited once a year, and whereon the body of Christ had been consecrated at a Mass said 100 years before.

Archaeological work done the past half-century has disclosed (cemetery of Herjolf-ness) that the bodies showed much malnutrition and steady deterioration of the population. The last burials show statures for men under five feet (never over) and women all were under four feet, nine inches. Fifty per cent died before their 30th year. The original Vikings settling there were probably tall, robust folk. In 1576 Martin Frobisher discovered Greenland. He believed that the few articles found among the Eskimo showed European contacts. In 1585 John Davis reached Greenland. He thought he was the real discoverer of the country, but he did find a burial place of a skin-dressed man upon whose grave lay a cross.

In Greenland the winters are long and cold and the sea is strewn with icebergs until late in spring. In the summer months there is a belt of vegetation on the West Coast. Behind tower the ice walls of immense glaciers and "Greenland's Icy Mountains" of the hymn book. The Kongespeilet gives a lengthy description of Greenland in Viking times which indicates that the climate is now much the same, but deteriorated, as in Iceland and the Scandinavian North, during the late medieval-early modern ages. The ground of the Greenland settlements towards the extinction time (14th and 15th Centuries) became frozen, as evidenced by the later burials. Permafrost arose to the surface soil so that the colonists needed to adopt the Eskimo culture or perish, C. E. P. Brooks (1949).

With deterioration of climate came restrictions of acreage. Eskimos told explorers that the old Greenlanders sickened because they could not get the proper foods. Some Scandinavian students of Greenland and Viking-Norman colonization believe the northernmost colony of weaklings was destroyed in 1345 A.D. by the Eskimos, who ate the same foods as they do now. The Eskimo is and has been peaceful. A newer

theory gaining credence holds that English pirates landed in Greenland, killing some of the colonists, as was their wont, and carrying off into slavery some of the others. There is correspondence to this effect between the Danish and English kings. Be that as it may, some of the survivors joined the Eskimo and adopted the suitable Boreal culture of the aborigines. In 1721 Hans Egede, famous Norse missionary, and the last to seek for the lost colonists, observed fair and dark and Mongoloid Eskimos. Hans Egede's children, who learned the Eskimo tongue, and other investigators, learned why and how the Greenlanders disappeared. Their European culture and foods were not suited to Boreal conditions. When malnutrition weakened them after long isolation, they joined with the "people of America," which seems likely from the historical and anthropological data now available. Other observers noted these types long afterwards and did not believe them to be the offspring of modern whalers and explorers.

Now comes K. Fischer-Moller (1942), a good anatomist and pathologist, who studied 61 remains of the colonists. He finds no evidence of malnutrition in this series and no clues as to the cause of the extinction. He excludes malnutrition, disease, and physical degeneration as possible causes! Of 31 skulls, 20 were Nordic, six "Alpine," and five showed Eskimo admixture. There were seven arthritics, but no syphilis, tuberculosis, or rickets were seen. There was no excessive wear of teeth. The weight of the total evidence now available does, however, show malnutrition, genetical defects,[1] and an adverse climate that affected stature of northern Europeans everywhere in their native habitat. Their food supply, as listed above, if available would be adequate and balanced—in fact, as good as any sturdy Paleolithic or Mesolithic folk had at their disposal.

There is some evidence that dietary causes of congenital abnormalities may exist and that nutritional inadequacy during pregnancy influences the course of development of the embryo, R. Woods (1944). The classic "Medical Survey of Nutrition in Newfoundland" (Canadian Med. Assoc. 52, 227-250, 1945) shows the effects of poor nutritional status of the people there, and implicates poor nutrition as responsible for impaired health and efficiency.

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[1] Henschen (1943) shows that folk of this ethnic compost who have lived in isolated communities for thousands of years show no evidence of increased pathological genes over incidence in other European peoples.

CHAPTER XV

Nutrition and Man's Welfare

Self-Selection

Obviously food is an eternal problem for all forms of life. In food-gathering times during the Pleistocene and much of the Holocene, hominids and finally men were, as we have seen, motivated largely by their food drives, and their foods were often spontaneously selected.

In writing on appetite guidance, Dr. C. G. King, Scientific Director of the Nutrition Foundation, stated that "Critical study of food selection according to appetite and physiological need in experimental animals has been completed at the University of Pittsburgh by Dr. E. M. Scott and his associates. Their observations show that some individual animals have 'automatic guidance' in selecting foods that are needed to preserve or regain health, but the degree of guidance varies greatly with different nutrients and from animal to animal. The total record shows convincingly that in each large group of animals, many had little or no appetite guidance for one or more nutrients essential to growth and survival. For example, many animals steadily lost weight and even starved to death for lack of protein, in a cage with free access to good quality milk protein. A failure to select magnesium salts was even more striking—that is, a higher proportion of animals in representative groups lost weight and died because of continued deficiency, when they had a free choice of salt mixtures with or without the essential nutrient. Food habits of men and animals, developed on the basis of experience and survival through many years or through successive generations, often merit a degree of respect and confidence. But a very different proposition is at stake when one hears the naive assertion that a child or adult living in a typical environment will be protected in health by the automatic choice of foods on the simple basis of taste and appetite. Dr. Scott has provided a critically needed appraisal of a physiological principle—that appetite response does not furnish a reliable basis for protection of health by spontaneous selection."

A large literature has grown on the subject of self-selection of adequate diets. As far back as 1897, Sir William Roberts wrote, "The generalized food customs of mankind are not to be viewed as random practice, adopted to please the palate or gratify an idle or vicious appetite. These customs must be regarded as the outcome of profound instincts which correspond to certain wants of the human economy. They are the

first of a colossal experience accumulated by countless millions of men through successive generations." The existence of a large animal population is proof, according to many writers, that the animals have chosen adequate foods. Mursell (1925), in a review of the literature on comparative and historical dietetics, concluded that "When we find widely sundered races with vast differences in tastes and preferences, in food, opportunities, and in habitat, still keeping to pretty much the same general balance of rationing, it is difficult to avoid the impression that we are in the presence of a very powerful auto-regulative mechanism which, given certain external conditions, strongly favors a certain proportion of intake from among the basic nutrient substances."

Ruth Woods (1949) in her Borden's Review of Nutritional Research observed that many authorities conclude that primitive human populations show an amazing ability to choose foods in accordance with their physiological needs, provided their choice is not unduly influenced by education, imitation, and other factors which she cites.

There are numerous instances in support of this belief to be found in the history of the food habits and customs of various populations. In Mexico, for example, a common practice in the preparation of tortillas involves the preparatory soaking of corn in a lime solution. By this means an appreciable quantity of calcium is absorbed and introduced into the diet, in a region where the production of calcium-rich dairy products is impracticable. In the rural cereal-consuming areas of North China cereals are eaten as mixtures, rarely as single grains. The biological value of the mixed cereals has been found to be invariably superior to that of single cereals (because of supplementation). The combinations of cereals were found to provide protein mixtures of high, often maximum, biological values. Again in China, the preparation of soybeans reflects an instinctive nutritional wisdom. Soybeans, unless subjected to prolonged heat treatment, are nutritionally inadequate. In the Orient, where soybeans form a large part of the diet, the vegetable is not cooked but is subjected to various processes, including germination (bean sprouts), fermentation (soy sauce), or infractionation (soybean curd). Each of these processes has been shown to improve the nutritive value of this food.

Of the primitive peoples noted for their wise choice of food, the Hunzas of northern India are perhaps the most renowned and extensively written about. Unlike neighboring tribes, the Hunzas are extremely hardy, possess superior powers of strength and endurance, and enjoy buoyant health. Further, they excel as skilled workmen and artisans and are of generally superior intelligence. During a seven-year

period of close observation and work among these people, McCarrison (1921) was led to the conclusion that diet was the outstanding factor responsible for the marked superiority of the Hunzas over the rest of the Indian population. They consumed cereal grains, vegetables, fruits (especially iron-rich apricots), milk, and butter daily. Goat's meat was eaten on feast days. As described by Rorty and Norman (1947): "On these meager rations the Hunzas lived long and merrily, mocked at their morose and dyspeptic neighbors, and gave McCarrison, as their physician, so little to do that his case records dealt mostly with accidents, the removal of senile cataract, etc."

In order to check his theory on the influence of the Hunza diet on health, McCarrison fed one group of rats a diet based on that of the Hunzas and another group diets typical of those of the undersized, disease-ridden Bengalis and Madrassie of the south of India. The rats fed the Hunza diet thrived, grew, and mated normally, had healthy offspring, and manifested no ills. The rats fed diets typical of the inhabitants of Bengal, Madras, Travancore, and other parts of India—polished rice, tapioca, pulse, vegetables, spices, and a small amount of milk—soon acquired a host of diseases, including pneumonia, sinusitis, ulcers and cancer of the stomach, pernicious anemia, enlarged glands, enlarged adenoids, goiter, polyneuritis, heart disease, premature birth. The temperaments of the animals were also affected. Those fed the Hunza diet were gentle, playful, and affectionate; others, fed a diet similar to that of the poorer classes in Britain, became irritable and vicious in behavior!

Not only the diet of the Hunzas but their agricultural practices—prescribed by rigid tradition—have been found to be extraordinarily well planned. Their fields are terraced in staircase fashion and the soil is irrigated and renewed by the silt-bearing water brought down by aqueducts from the glaciers of the surrounding mountains. This provides a never ending source of mineral supplements. All human, animal, and vegetable refuse is meticulously returned to the soil.

An interesting example is the study reported by Orr and Gilks (1931) on the food habits of two neighboring East African tribes, the Masai and the Akikuyu. The Masai live almost entirely on meat, milk, and fresh blood. They are healthy and vigorous. The Akikuyu, on the other hand, live chiefly on cereals and potatoes. The eating of green vegetables is considered effeminate and further, according to Akikuyu superstition, prevents the men from being swift of foot, if defeated in battle by the Masai. Although they maintain herds of goats, economic custom has resulted in these being used for currency instead of as a source of meat or milk. For these reasons, the Akikuyu—particularly

the male—is less healthy and sturdy than his neighbors. The average male adult is about five inches shorter and 25 pounds lighter than the Masai male. The children suffer from bone deformities, anemia, and enlarged tonsils. There is still a great number of people throughout widely scattered areas of the world suffering from malignant malnutrition, due largely to rice and corn diets known to be grossly inadequate in protein, Food and Agriculture Organization of the United Nations (1950).

Dr. Louis Berman (1932) discusses the metabolism and nutrition of leadership and believes food affects character and personality in three ways: (1) acts on blood, (2) influences endocrine or glandular systems by stimulation or depression, (3) furnishes the raw materials for these glands, the brain, and the nervous system. The whole is interlocking, but Dr. Berman believes there are chemical differences in man, and in his practice he observed "Unbalanced diet leads to unbalanced minds." Transformation of character and personality has been achieved, Berman says, by means of treatment of the endocrine glands, aided by modifications of diet. Personality changes in man follow restrictions of the vitamin B complex and are manifested as tiredness, neurasthenia, melancholia, and hysteria.

The laboratory workers in this field are either slow or reluctant to subscribe to the validity of observations like those just cited, because their criteria are extremely rigid and their discipline has come the hard way. Nevertheless, anthropologists and nutritional authorities have recorded instances in support of these contentions. Clara Davis (1939) has summarized these experimental investigations with the thought that "Self-selection can have no, or but doubtful, value if the diet must be selected from inferior foods."

Starvation

When we view the million, half-, or quarter-million years of man's existence on earth (depending on the chronologies you may prefer), 99 per cent of the time he was a food gatherer. He evolved and obviously survived. We have seen how he ate creatures that hop or crawl, run or swim; or dug roots, gathered fruits and nuts in season; and how drastically his foods changed with the seasons and epochs. Undoubtedly many isolates succumbed to nutritional deficiencies or frank starvation during the long span of the human period. Dr. Ancel Keys and his group (1950) at the University of Minnesota performed comprehensive experiments on starvation and rehabilitation using 32 human subjects, volunteers in a year-long experiment. They provided new

insight into the problem of starvation, its consequences, and the response to subsequent nutritional therapy. It has been estimated that 80 per cent of the world population suffers from some degree of undernutrition; many millions are existing in a state of semistarvation. Accurate scientific knowledge concerning the effects of malnutrition in war-ravaged countries was desperately needed. To this end their experiments were planned to determine physiological, psychological, and performance characteristics of a group of normal men, first on an adequate diet and then on a European famine diet designed to cause loss of one-fourth the body weight in six months. Following this, the men were rehabilitated on different controlled relief diets so as to estimate the effects of different caloric, vitamin, and protein levels on the character and rate of recovery. The semistarvation diet consisted mainly of potatoes, turnips, and coarse cereals; meat, fish, cheese, and eggs combined totalled only about one ounce a day. The diet provided 1,760 calories (normal requirement of subjects about 3,150), 49 gm. of protein, and fair amounts of vitamins and minerals. The subjects exhibited progressive and severe weakness, depression, fatigue, anemia, bradycardia, and edema. There were slight disturbances in coordination, speed of reactions, and in amount of plasma proteins. Vision, hearing, and intelligence remained unimpaired. Vitamin deficiency signs were not obvious. In rehabilitation it was found that only diets averaging over 2,500 calories daily allowed significant recovery, and with the best diet, averaging about 3,500 calories, recovery was only about 50 per cent in three months. Extra vitamins and proteins had little apparent effect on the rate or course of recovery.

Today nutritionists, with their strong humanitarian outlook, are perturbed greatly from their knowledge that malnutrition exists everywhere to a greater or less extent and that starvation ever confronts most Asiatics. The United Nations Conference on Food at Hot Springs, Virginia in 1943, agreed that "There has never been enough food for the health of all people." Although we have much to learn about the chemistry of vital processes, enough is known that man by controlling his nutrition can attain the desired goals in health and welfare. Dr. C. A. Elvehjem (1946) concluded, "Previous to the 20th Century, thousands and more likely millions of people suffered and died because of a lack of scientific knowledge about vitamins or of an insufficient supply of foods rich in these essential nutrients."

Sir Frederick Gowland Hopkins of Cambridge thought no nation in history had ever been fed on a properly balanced diet. We have concrete evidence that the Jews with their dietary habits rigidly controlled

by religious regulation, may have experienced selection of individuals during the centuries, but at the same time their food selection has saved countless members from the ravages of malnutrition, parasitic worms, bacteria, and epidemic plagues. Food has played as important a role in human character as climate, although the two were hopelessly intertwined before the advent of rapid and refrigerated transport.

Elements of Nutrition

When in the early days of the 20th Century the science of nutrition gained recognition, there was a tendency to seize upon it as a panacea. The result was a flood of unsound theories. Fads in foods and diets sprang up overnight, to win great popularity and then to disappear just as quickly. Within the past generation the science of nutrition has made sound and stable advances—greater progress than in all the preceding centuries.

The basic importance of nutrition to all phases of biology is well recognized. Biology can be divided into studies dealing with structure and those dealing with function. Nutrition plays an important part in both. The growth and structure of an organism depend in part on the nutrients available, and the function of an organism depends in part on the nutrition. To summarize the need and importance of nutrition in simple statements, one may say that good nutrition is necessary for

1. Growth and maintenance of the body.
2. Normal functioning of the body.
3. Energy for warmth and activity.

Nutrition can be thought of in terms of chemical units—the nutrients provided by food, such as protein, inorganic salts, and various vitamins —or in terms of food. Foods have been assayed for their content of specific nutrients, the effect of processing and preserving on nutrient content has been studied, and foods can be given some specific evaluation in terms of their particular contribution to nutrition.

The history of the science of nutrition is that of finding that food consists of more than one nutrient and that these nutrients have specific physiologic jobs to do.

From approximately 1834, when the single universal nutrient in food was subdivided into three components (carbohydrate, protein, and fat), until 1949, when the discovery of animal protein factor B_{12} was announced, there have been approximately 50 to 60 essential nutrients isolated from food—and the end is not yet reached.

Foods and Their Nutrilites

Dr. Frederick J. Stare (1950) has listed approximately 50 nutrients that have been found to play a role in nutrition:

Protein—The following amino acids: alanine, arginine, aspartic acid, beta-hydroxyglutamic acid, cysteine, cystine, glutamic acid, glycine, histidine, hydroxyproline, isoleucine, leucine, lysine, methionine, norleucine, phenylalanine, proline, serine, threonine, tryptophane, tryosine, valine. Outstanding food sources of protein: meat, fowl, fish, milk, eggs, peas, beans, and whole grain cereals.

Fat—For energy and for the following fatty acids: arachidonic, linoleic, linolenic. Outstanding food sources of fat: butter, lard, fatty meats, cream, cheese, vegetable oils, margarine, and shortenings.

Carbohydrate—For energy: outstanding food sources of carbohydrate: sugar, wheat, corn, rice, and other grains.

Minerals—Calcium, chloride, cobalt, copper, fluorine, iodine, iron, magnesium, manganese, phosphorus, potassium, sodium, sulphur, zinc. Outstanding food sources of minerals: iodized table salt, protein foods, vegetables, fruits, and cereals.

Vitamins—Fat-soluble—vitamins A, D, E, K. Outstanding food sources: green and yellow vegetables, cream, butter, enriched margarine, tomatoes, egg yolk, organ meats such as liver—fish-liver oils for vitamins A and D, sunshine for vitamin D, wheat germ and corn oil for vitamin E. *Water-soluble*—ascorbic acid (vitamin C) and B-complex: thiamin, riboflavin, niacin, biotin, choline, folic acid, inositol, pantothenic acid, para-aminobenzoic acid, pyridoxine, and vitamin B_{12}.

Outstanding food sources: fruits, particularly citrus and tomatoes for ascorbic acid; protein foods and vegetables for the B-complex vitamins.

While not all of the above-mentioned nutrients have so far been found necessary in normal human nutrition, the chances are good that future studies will show their need. Thus we may say that certain foods are necessary for good nutrition because they supply the body with 50 to 60 specific chemical substances—nutrients—and that all of the nutrients in food essential for human health are still not known. A clear understanding of the function and quantitative requirements for man are known for only a few of the nutrients. There is still much research to be done in the science of nutrition.

Vitamins

Historically, vitamins are divided into two main chemical categories on the basis of general solubility in fat solvents or water. The fat-

soluble vitamins are four in number, vitamins A, D, E, and K. Vitamins A and D are the only fat-soluble vitamins of practical importance in the diet of normal man. Vitamin E has a number of interesting biochemical properties that make it of interest in biology, but its role in human nutrition is not known. Vitamin K is one of the factors necessary for the clotting of blood. Normally man receives adequate amounts of vitamin K from synthesis by the bacteria that make up the flora of the lower intestinal tract, and hence is not dependent on food as a source of this vitamin.

Water-soluble vitamins now number about 15 nutrients, all of them usually classified as members of the B-complex, except ascorbic acid (vitamin C). The latter is the vitamin associated with citrus fruits, tomatoes, and raw cabbage. The use of the word *raw* with *cabbage* emphasizes the ease with which this particular vitamin (vitamin C) is destroyed by oxidation and heat. Some of the water-soluble vitamins are associated with the classic deficiency diseases: (lack of ascorbic acid with scurvy, lack of thiamin with beriberi, lack of niacin with pellagra, and lack of vitamin B_{12} with pernicious anemia).

The B-complex vitamins, historically associated on the basis of water-soluble substances obtained from yeast, liver, or rice husks, include thiamin, riboflavin, niacin, biotin, pyridoxine, pantothenic acid, and others, including the latest to be added to the list—vitamin B_{12}. Of particular interest is the fact that the biologic function of most of the B-complex vitamins is reasonably well known. Most of them are concerned with specific chemical reactions in the intermediatory metabolism of carbohydrate, fat, and protein. They are part of the enzyme systems necessary for the utilization of energy from foods. American Meat Institute biochemists, under the leadership of Dr. H. F. Kraybill, discovered that the amino acid tryptophane (an important constituent of meat) can be transformed by the body tissues to the vitamin, niacin.

The fat-soluble vitamins, their functions, deficiency signs, and occurrence in a few foods, are listed (Table 11).

Nine of the water-soluble vitamins are listed (Table 12), for ready reference in evaluating the foods we have mentioned in the historical sections.

Diets

Each human being has a metabolic pattern which differs in numerous respects from those of individuals in his group. At the present time much information is needed. We can state, however, that in solving the problem of nutrition, very little progress has been made in terms of diets that are good for everyone.

TABLE 11

Fat-Soluble Vitamins

Vitamin	Functions	Deficiency signs	Food sources	
A			*per 100 g.*	*I. U.*
Carotenoid and yellow pigments	Stimulates cell growth, aids in resisting infections. Regeneration of visual purple. Longevity increased, delays senility.	Night blindness. Disorders of eye and conjunctiva. Dry skin.	Liver, fresh	19,200
			Carrots	12,000
			Dandelion greens	13,650
			Butter (av.)	3,200
			Cheese (av.)	2,000
			Eggs	1,140
			Cantaloupe	3,400
D			*per 100 g.*	*I. U.*
Related to sterols	Aids absorption of calcium. Regulates blood calcium. Aids in bone formation.	Affects chiefly bones and teeth. Rickets.	Egg yolk	300
			Herring	1,800
			Halibut—liver oil	60,000
			Butter	8 to 40
			Liver	20
			Salmon	500
E			*mg./100 gm.*	
Tocopherols	Normal reproduction. Prevents oxidations of unsaturated fatty acids.	Degeneration male germinal. Epithelium. Resorptive failure of pregnancy. Impairs growth. Muscular dystrophy. Kidney disorders.	Wheat germ oil	320
			Whole wheat flour	2
			Whole rye	3
			Wheat germ	27
			Eggs	3
			Meat	8
			Oatmeal	2.1
			Olive oil	8
			Parsley	5
K			*mg./100 gm.*	
	Normal blood clotting.	Long clotting time. Multiple hemorrhages.	Cabbage	3.2
			Wheat and cereals	0.05 to 0.30
			Spinach	4.6
			Cauliflower	3.2
			Liver	0.8
			Green peas	3

The essential unsaturated fat acids: effect on man not known, but exert profound effect on laboratory rats (skin, hair, reproduction).

TABLE 12

Water-Soluble Vitamins

Vitamin	Functions	Deficiency signs	Some food sources	
			micrograms/100 gm.	
B_1 Thiamin	Good appetite Good digestion Growth, fertility Lactation	Beriberi, neuritis Muscular atrophy Brain lesions Gastro-intestinal disturbances	Wheat germ	2,050
			Whole wheat	450
			Whole rice	290
			Pork	1,000
			Whole rye	470
			Hearts	540
			Oatmeal	550
			Green peas	350
			micrograms/100 gm.	
B_2 or (G) Riboflavin	Cellular oxidations	Corneal cloudiness Cataracts Dimness of vision Dermatitis, tongue lesions, neuritis, anemia, impairment of growth	Liver	2,800
			Wheat germ	800
			Whole wheat bread	280
			Cheddar cheese	500
			Eggs	340
			Lamb	250
			mg./100 gm.	
Niacin	Functional group of co-enzymes I, II	Pellagra (3 D's = diarrhea, determatitis, dementia); also associated with poor quality protein, like maize	Wheat grain	4.2
			Wheat germ	4.6
			Brown rice	4.6
			Pork	4.5
			Green peas	2.1
			Liver	16.1
			Lamb	5.5
			Most fish	4.0
			Beef	5.5
			Chicken	8.6
			micrograms/100 gm.	
Pyridoxine B_6	Co-enzyme Metabolism of unsaturated fat acids	Affects red blood cells, anemia, nervous symptoms	Wheat germ	600
			Veal	130
			Pork	270
			Beef	77
			Liver	800
			Apples	26
			Eggs	22
			Cabbage	290
			Milk	6

TABLE 12 (concluded)

Vitamin	Functions	Deficiency signs	Some food sources	
			micrograms/100 gm.	
Pantothenic acid	Essential for all living organisms and man; fat and carbohydrate metabolism; utilization of other vitamins	Circumoculae loss of hair Grey hair in animals Diarrhea "Burning" hands and feet in man Neuritis	Whole wheat	1,300
			Wheat germ	2,000
			Wheat bran	2,400
			Veal	260
			Salmon	1,000
			Pork	1,500
			Peas	1,000
			Oysters	490
			Oats	1,300
			Milk	290
			Lamb	600
			Eggs	2,700
			Beef	1,100
			mg./100 gm.	
Inositol (Bios I)	Concerned in fat metabolism	Not known, but impaired growth in laboratory animals	Whole wheat	170
			Wheat germ	690
			Veal	35
			Salmon	17
			Pork	45
			Green peas	162
			Oysters	44
			Eggs	33
Biotin (Bios II)	Involved in fat metabolism Co-enzyme in growth mechanisms	Erythemia, dermatitis, atrophy of muscle, pain, grey skin in man, loss of appetite, involves heart. Avidin in egg white combines with biotin and thus unavailable but unlikely avidin combines with all in body	All normal diets. Synthesized by bacteria in intestine	
Folic Acid, choline, P, rutin, = not known in humans				
			mg./100 gm.	
Ascorbic acid C	Formation of intercellular substances, tooth formation, bone formation, wound healing, red blood cells, metabolism, glandular activities	Scurvy, bone changes, tooth changes, but not caries	Lemons	45
			Limes	27
			Broccoli	118
			Strawberries	60
			Liver	31
			(Most fruits and vegetables, but open-kettle cook—also wilting—may destroy.	

Dietary interrelationships [like pyridoxine and amino acid metabolism, the antivitamins, nicotinic acid and tryptophane, tryptophane as a precursor of niacin, glucose and niacin, vitamin C and the cortical hormones (adrenal), carbonic anhydrase and brain, vitamin C and metabolism of aromatic amino acids, fats and carbohydrates, and many more, including the importance of phosphatase enzymes in formation of bones, teeth, growth, repair, muscular function, and nutrition, which has opened up a new view of interrelationships of enzymes, hormones, and the vitamins] may revise current practices in estimating dietary adequacy from tables of food values alone.

Practical nutrition is concerned with the nutritive value of the diets and not of individual foods. Because of supplementary relationships, diets must be considered as a whole. For example, cereal and grain proteins are deficient in several amino acids including lysine. Milk on the other hand, is low in cystine and methionine but provides a large amount of lysine, tryptophane, isoleucine, and valine. Thus milk and bread or cereal mutually supplement in combination, providing a well-balanced protein mixture. Similarly, meat and cereal provide this balance. Obviously then, the entire mixtures or diets with all nutrilites eaten simultaneously are essential for proper nutrition. The time factor, illustrated by lack of protein for breakfast, may impair nitrogen utilization more than its lack at dinner at noon.

We should not think of nutritional deficiencies manifesting themselves by flagrant and unmistakable signs of scurvy, beriberi, xeropthalmia, and rickets. Nutritional deficiencies may injure a population without these dramatic clinical manifestations. The evolution of a nutritional status of a man or a people is involved with many factors, taboos, racial types, age, personal idiosyncrasies, and income sufficient to eat properly and regularly. In the case of Egyptian slaves and artisans, of whose dietary we have full account for several thousand years, their well-being and status followed nutritional patterns.

During the past 20 years the significance of proteins (meat, fish, dairy products, eggs) in nutrition came to light in studies of nitrogen metabolism. Today proteins are not only regarded as a source of anabolic nitrogen, calories, and appetite stimuli, but "have taken the position of a therapeutic agent comparable to digitalis or the sulfonamide compounds." G. V. Mann and F. J. Stare (1950). This observation resulted from the fact that certain amino acids of proteins are "essential," so that emphasis is now placed on essential nutrients (essential amino acids, vitamins, minerals) rather than on the foods representing the natural mixtures of these substances.

If one measures the dietary nitrogen eaten, and the total nitrogen excreted in urine and stools, a "balance sheet" can be made of figures which represent loss or gain of nitrogen by the body. The body is "in balance" when the intake is equal to the loss. The fraction of dietary nitrogen retained in the body is very important and is called the "biological value" of the protein.

Most nutritionists maintain stoutly that nutrition is the most important single environmental factor affecting health.

Professor H. C. Sherman (1943) discusses the *Protein Shift,* a fact of observation that at the present general stage of human history (20 to 40 generations) people who of necessity are living largely on starchy foods show a tendency to eat more protein when their economies permit. Some economists regard the Protein Shift as a well-established phenomenon in many countries, simultaneously or successively as their economic conditions have permitted; it can often be seen in progress as different economic strata of population succeed in improving their standards of living. We have followed the phenomenon of Protein Shift in Classic Times, L. B. Jensen (1949). However, present-day views throw emphasis on balanced diet, which is outlined simply in Canada's Food Rules:

"These foods are good to eat.
Eat them every day for health.
Have at least three meals each day.

1. Milk—Children (up to about 12 years): at least one pint. Adolescents: at least 1½ pints. Adults: at least ½ pint.
2. Fruit—one serving of citrus fruit or tomatoes or their juices; and one serving of other fruit.
3. Vegetables—at least one serving of potatoes; and at least two servings of other vegetables, preferably leafy, green or yellow, and frequently raw.
4. Cereals and bread—one serving of whole grain cereal, and at least four slices of bread (with butter or fortified margarine).
5. Meat and fish—one serving of meat, fish, poultry, or meat alternates such as dried beans, eggs, or cheese. Use liver frequently. In addition, eggs and cheese at least three times each week. Vitamin D—at least 400 I.U. daily for all growing persons and expectant and nursing mothers. Iodized salt is recommended."

The recommended dietary allowances of the National Research Council, Washington, D. C. (1948), published by the Food and Nutrition Board, lists a daily allowance for a 150-pound active man as

Calories—3,000
Protein—70 gm.
Calcium—2 mg. (phosphorus 1½ times calcium)

Iron—125 µg.
Vitamin A—5,000 units
Thiamin—1.5 mg.
Riboflavin—1.8 mg.
Niacin—15 mg.
Ascorbic Acid—75 mg.
Vitamin D—400 I.U. or less
Visible and invisible fat—20 per cent of total calories
Unsaturated fats—1 per cent of total fat
H_2O—2.5 liters daily
Salt—about 5 gm. daily
Iodine—0.002 mg.

According to the early studies, any amino acid whose absence in the diet resulted in growth failure or death was classified as essential. Using growth of rats as the criterion, and working with mixtures of purified amino acids, a classification of the 23 amino acids into essential and nonessential was worked out. On this basis, Dr. Wm. C. Rose and colleagues, after two decades of intensive laboratory study, discovered that 10 amino acids are required in the diet of the rat for optimum growth and that the remaining amino acids may be omitted, inasmuch as they are probably synthesized in adequate amounts at rates commensurate with the demands for normal growth.

FINAL CLASSIFICATION OF THE AMINO ACIDS WITH RESPECT TO THEIR GROWTH EFFECTS IN EXPERIMENTAL WHITE RATS

Indispensable	Dispensable
lysine	glycine
tryptophane	alanine
histidine	serine
phenylalanine	norleucine
leucine	aspartic acid
isoleucine	glutamic acid
threonine	hydroxyglutamic acid
methionine	proline
valine	hydroxyproline
*arginine	citrulline
	tyrosine
	cystine

*Arginine can be synthesized by the animal organism, but not at a sufficiently rapid rate to meet the demands of normal growth. Arginine and histidine are not required by man.

The reader may refer to Table 13 for information about the occurrence of essential amino acids in historical foods. The position of maize as to essential amino acid content shows reasons for supplementation taught by history and biochemistry.

TABLE 13

Essential Amino Acids of Whole Food [1,2]

Food	Arginine	Histidine	Isoleucine	Leucine	Lycine	Methionine	Phenylalanine	Threonine	Tryptophane	Valine
	pct.	*pct.*	*pct.*	*pct.*	*pct.*	*pct.*	*pct.*	*pct.*	*pct.*	*pct.*
Whole egg	1.19	0.45	0.86	1.19	0.96	0.48	0.86	0.61	0.20	0.89
Lean beef	1.51	0.67	0.86	1.16	1.23	0.72	0.53	0.72	0.22	0.78
Horsemeat	1.68	0.81	0.99	0.91	1.47	1.21	0.69	0.85	0.12	1.03
Halibut, Haddock } av.	1.70	0.69	1.23	1.71	1.88	0.85	0.70	0.76	0.23	1.17
Soya bean, fat extracted	2.75	0.90	1.42	1.90	1.48	1.80	1.28	1.31	0.54	1.35
Navy beans	2.10	0.67	1.28	1.83	1.43	0.86	0.76	0.72	0.11	1.34
Defatted peanut	7.62	1.66	2.55	3.77	1.67	1.90	1.57	1.45	1.10	2.94
Defatted sunflower seeds	5.46	1.43	2.78	3.71	1.45	1.61	2.39	1.64	1.14	2.70
Whole barley	0.61	0.26	0.51	0.84	0.42	0.19	0.62	0.48	0.19	0.61
Buckwheat flour	1.05	0.25	0.45	0.74	0.70	0.22	0.50	0.48	0.20	0.66
Cheddar cheese	0.82	0.66	1.27	2.30	1.92	0.63	1.25	0.88	0.35	1.43
Meal, corn (maize)	0.45	0.24	0.36	1.11	0.29	0.21	0.46	0.34	0.032 to 0.082	0.50
Whole milk	0.12	0.086	0.22	0.34	0.23	0.10	0.19	0.18	0.05	0.25
Oatmeal	0.99	0.31	0.63	1.14	0.62	0.25	0.78	0.48	0.23	0.86
Unpolished rice	0.54	0.14	0.28	0.51	0.28	0.14	0.31	0.22	0.098	0.40
Whole rye	0.59	0.25	0.44	0.67	0.45	0.18	0.47	0.37	0.14	0.56
Whole wheat	0.63	0.31	0.58	0.91	0.35	0.22	0.70	0.38	0.19	0.64

Variations in amino acid content of samples of the same kind of meat taken from the different animals were in most instances very small. Histidine content of muscles showed wide variations. Meat was an outstanding source of lysine as compared with grains and vegetables and was an excellent source of amino acids.

[1] L. E. Edwards, *et al.* (1946). Biological value of proteins in relation to the essential amino acids which they contain. J. Nutrition, **32**, 597-612.

[2] C. M. Lyman and K. A. Kuiken (1949). The amino acid composition of meat and some other foods. Bull. 708. Texas Agr. Sta., College Station, Texas.

Some of the essential minerals and vitamins of familiar foods in pre-history and in food-producing times are shown (Table 14). It becomes apparent that foods in pre-history and in historical time, as well, could supply a balanced diet. Quantity was often the limiting factor. In case of the Amerinds, unlike the maize-polenta eaters of Europe who developed severe deficiency diseases, we observe a regular supplementary dietary of protein-rich beans in Mexico and in the Southwest when game was scarce, G. C. Vaillant (1950). The Amerinds of both continents of the New World supplemented maize foods with guinea pigs in South America and fish and game in North America. This they taught the Colonizing Europeans to do in North America, but the lesson was not well learned, as we know from the high incidence of pellagra and deficiency diseases in populations in which corn, molasses, and fat pork were and are the main articles of food. The only excuse to be made for this condition is "There are more bad new ideas than good ones." At any rate, there is no single food which may be called essential.

Washington Irving (1783-1859) wrote with humor in his "Sketch-Book," "But, I was anxious to see the great men of Europe; for I had read in the works of various philosophers, that all animals degenerate in America, and man among the number." Corn foods, potatoes, and tomatoes were generally looked upon with disfavor by the European Great until quite recent times. Professor C. O. Sauer (1916) called attention to the plight of Illinois pioneers. The matted roots of the prairie grasses formed a tough, heavy sod which the pioneers found difficult to break with the weak tools and few draft animals in their possession. They believed that "poisonous miasmas" were liberated in breaking the prairie sod late in summer or autumn. Some of the pre-historic mounds or camp sites in mid-America were also thought to liberate "fevers and miasmas" when dug into or opened. They dug shallow wells which were all that was needed for water on the grassy prairies. Their fare was cornmeal, hominy, fresh and salt pork, and potatoes. Their fevers, agues, trembles, melancholia, and "deadly homesickness" may have been due in part to malnutrition instead of the "miasmas." The same picture was seen in western Iowa immediately following the Civil War, where at first there was some reluctance to settle and plough the prairies, "where trees did not grow."

The Greek, Arabian, and Roman writers do not seem to be acquainted with scurvy and this is, as we suspect, because of the plentiful fruit supply in these southern countries. De Joinville describes classic scurvy among St. Louis' Crusaders in 1250, during their invasion of Egypt. These Crusaders ate no meat for it was Lent, but consumed a species of eel.

TABLE 14

Some Essential Minerals and Vitamins in Familiar Foods

Per 100 gm. edible portion	Calcium	Phosphorus	Iron	Vitamin A	Thiamin	Riboflavin	Niacin	Ascorbic Acid
	mg.	*mg.*	*mg.*	*I. U.*	*mg.*	*mg.*	*mg.*	*mg.*
Cheddar cheese	873	610	0.57	1,740	0.04	0.50	0.2	0
Fresh milk, whole	118	93	0.07	160	0.04	0.17	0.1	1
Whole eggs	54	210	2.7	1,140	0.12	0.34	0.1	0
Beef, lamb—medium grade	11	203	2.8	0	0.12	0.15	5.1	0
Pork, medium	7	128	1.8	0	0.75	0.15	3.2	0
Fish, medium fat	21	218	1.0	......	0.07	0.07	4.2	2
Oysters	68	172	7.1	......	0.18	0.23	1.2	....
Navy beans	148	463	10.3	0	0.60	0.24	2.1	2
Fresh beef liver	8	373	12.1	19,200	0.27	2.80	16.1	31
Peas	73	397	6.0	370	0.87	0.29	3.0	2
Whole soybeans	227	586	8.0	110	1.14	0.31	2.1	trace
Peanuts, roasted	74	393	1.9	0	0.3	0.16	16.2	0
Fresh corn (all varieties)	9	120	0.5	390	0.15	0.14	1.4	12
Fresh apples	6	10	0.3	90	0.04	0.02	0.2	5
Whole wheat flour	38	385	3.8	0	0.56	0.12	5.6	0
Buckwheat	11	88	1.0	0	0.31	0.08	2.1	0
Rye	61	369	4.8	0	0.47	0.21	1.7	0

Hess (1920) believes scurvy existed in northern Europe and northern Asia since man's first appearance there, for it continued to be rife there and elsewhere (outbreaks at sea) until the rise of nutritional science, although Lind in 1752, and Johannes Bachstrom in 1734, who coined the term "antiscorbutic," described the entity and treated it with sauerkraut, infusion of barley, very fresh meat, fresh milk, citrus fruits, fir-top and pine-needle infusion, and dandelion leaves. Bachstrom found leafy vegetables better than tubers or roots.

John Hall, a physician of Warwickshire, son-in-law of William Shakespeare, wrote on treatment of scurvy—a quaint work entitled, "Select Observations on English Bodies, or Cures Both Empericall and Historical." In London of 1657 they discussed "scorbutick hearbs, scurvy grass, water-cresses, and brook lime." Hess observes this book ran through two editions but did not achieve the popularity of the works of the father-in-law.

Scurvy without adequate treatment led to lasting afflictions. Even one siege rendered the patient heir to joint ills and gastro-intestinal troubles.

While there are gaps in present knowledge on diet and aging, it is thought that health during old age and the length of man's life, like the majority of biological characteristics, are the result of interaction between "heredity and environment." Among the environmental factors, nutrition undoubtedly plays a prominent role. The degenerative changes during middle age and old age may be established in early periods of adult life, or in growth of youth, which is profoundly influenced by nutrition.

Animal protein may be an important factor in the aging process. In animal feeding tests it has been observed that rats fed purely vegetarian diets were stunted in growth, and that life-span was shorter. According to white rat feeding data, thiamin, vitamin A, vitamin B complex, and calcium, all increase life-span. Undernutriture in many parts of the world, and excess caloric nutriture, are problems of the first order of importance. Overweight is one of the important forms of malnutriture. At present, the increase in number of deaths due to degenerative diseases, i.e., cancer, diabetes, and arteriosclerosis presents baffling problems to medical science, including the science of nutrition. Among the environmental factors, nutrition is likely to play a prominent role.

There are several factors which tend to create malnutrition of the aged. They are related to social and economic conditions (low incomes, poor cooking knowledge and facilities), mental outlook (worry from insecurity, ignorance of nutritional facts, mental deterioration), physical

factors (lack of exercise, poor teeth), and pathologic conditions (inadequate amount of hydrochloric acid). The complex etiology is illustrated in the case of anemia of nutritional origin. It may result from inadequate income for the purchase of eggs and meat; or from poor digestion of such foods, due to inadequate gastric secretion. An effective remedial treatment must be based on knowledge of the specific factors producing malnutrition.

Fats in the Diet

It is well known that fats are required for the building and activity of body tissues. They are a concentrated form of energy, as indicated by the fact that the necessary caloric value of the diet cannot easily be obtained without including them. Fat yields more than twice as many calories as the same quantity of protein or carbohydrate. Many early investigators in the field of human nutrition believed the only role of dietary fat was to serve as a rich source of calories. However, in addition to its function as an energy source, fat has an important place in the dietary because it aids in human well-being, has the ability to impart flavor, especially richness of flavor, to change texture of, and add attractiveness to, foods. Furthermore, it serves as a carrier of the fat-soluble vitamins and as a source of the essential unsaturated fatty acids.

It has been demonstrated recently with white rats that digestion and retention of food nitrogen were highest with a diet containing 30 per cent fat, and that the energy expense of utilization of isocaloric diets decreased with increasing dietary fat. This effect is attributed to increased efficiency of utilization of the diet with a higher fat content.

As a result of extensive research in the last quarter-century, many other important functions of fat besides furnishing calories are known and accepted. Also, the presence of fat helps with the absorption and utilization of other nutrients. Fat deposited in the body serves as an insulator against heat loss, and as a padding it protects the organs against shock.

Then, too, a diet without fat would be bulky and would lack the flavor and satiety value which fats give to it. The presence of fats in a mixed dietary may decrease the SDA of the three basic nutrients and thus promote optimal utilization of protein.

Through research with experimental animals it has been found that fat in the diet improves reproduction, lactation, food utilization, and physical health of the animals. Certain unsaturated fatty acids present in some fats are essential to the normal nutrition of the rat. If the rat's diet was deficient in fat, it did not grow normally. It was also found

that certain constituents of fat were essential to health of the skin. When the animal's diet was depleted of fat or low in fat, the skin was scaly and the hair dry. The addition of lard to the diet made the skin appear normal again.

As a result of these findings with experimental animals, observations have been made on the role of fat in man's diet. Fat is recognized as a rich source of energy. On the basis of weight it supplies more than twice as many calories as carbohydrate and protein. In addition to being a concentrated source of energy and a carrier of fat-soluble vitamins, fat adds satiety value and imparts richness to the diet. Also, fat is necessary for the proper digestion and absorption of foods. The relationship of fat to the health of the skin is another area of emphasis at present.

Fat is present in many foods other than fats and oils. The ingestion of a well-balanced diet which contains sufficient amounts of meat, milk, and eggs, and a source of essential unsaturated fatty acids, such as lard, will assure an intake of the fat needed for optimal health. For the adult who is moderately active, about 30 to 40 per cent of the total calories of the diet should be obtained from fat.

Sergius L. Ivanov [Chemical Abstracts, (1927-1940)] in numerous communications stated that warm climates lower and cold climates raise the quantity of unsaturated fat acids in plant and seed fats. Linolenic acid and other unsaturated fats are most sensitive to climatic conditions because these acids, with their three double linkages, are easily oxidized and readily absorbed by plants where the fat acids develop heat. This action appears whenever plants are obliged to accommodate themselves to cold climates, and dates back to the conifers at the end of the Paleozoic Age.

A given composition of the depot fat of the body acquired directly from food fat demands constancy in the food which does not always obtain. The composition of bone marrow fats is much the same as other fat deposits of cattle, reindeer, pigs, and horse. Human body fat is similar to the depot fats of many land animals and generally conforms to food patterns. The effects of olive oil and sesame oil on the populations of the Fertile Crescent, and the effect of the harder fats on some European and Asiatic populations have not been studied.

Rosenfeld (1902) "stuffed" a dog for one month with suet fat. The dog showed a "pure mutton fat in its tissues." Rosenfeld was of the opinion that a lion if devouring nothing but sheep would necessarily put on sheep fat. In these instances the respective animals would literally be "a dog in sheep's clothing" and "both a lion and a lamb." It is now known that the Mexican puma which feeds largely on sheep and young

deer possesses fat similar to bodily fats of sheep. A great deal of investigational work has been done in this field (see Hilditch, 1947). Livestock men know that feeding soy beans, linseed, or acorns produces soft pork fat in swine.

The effect of mammoth fat, reindeer fat, horse fat, mutton and bison tallow in the diets of Pleistocene men is obviously unknown, but fat depots in the Mongoloids afford physical protection from cold. The Beresovka Siberian mammoth possessed 3.5 inches of subcutaneous fat all over the animal (its tail was much shorter than the elephant's, an adjustment to the nips of Jack Frost).

Sergius Ivanov's work mentioned above shows increasing unsaturation of fats in the geographical sweep from the tropics to the Arctic in plants, their seeds, and the animals which eat them. These unsaturated fats are, for instance, retained to some extent in the laboratory rat on fat starvation diets, and growth ceases until more of these unsaturated fat acids are provided (Ida Smedley-Maclean, 1943). The unsaturated fats possess low melting points and high heat content, make for fluidity of fats, but increase the tendency to become rancid. The degree of unsaturation of a food fat as well as depot fats must be kept within narrow limits in order to make life possible on land. The higher fat acids (C_{20} plus) in quantity are generally limited to aquatic fats, and are said not to be too evident when life emerges up on land.

Composition of fats is closely related to the development of biological species and to the place of the parent plant or animal in the evolutionary system. The fat acids of the more primitive forms of aquatic life are very complex, containing large proportions of polyethenoid acids of 18, 20, 22 carbon atoms. In the more highly developed land animals and plants the fat acid mixture is much simpler (animals: palmitic, oleic, stearic; plants: oleic, linoleic, palmitic, and a wide variety in fruit fats or seed fats).

Sugar

Carbohydrate is the largest source of energy in average diets the world over, furnishing from 50 to 75 per cent of the total caloric intake. The main food sources of carbohydrate are sugar, flour, and rice. Carbohydrate is stored in plant products as starch and in animal products as glycogen. Both starch and glycogen are broken down in the process of digestion, to the simple sugar dextrose which the cells of the body utilize for energy.

The cultivated sugar canes are derived from wild species of *Saccharum* (*S. robustum, S. spontaneum*). Canes appear to hybridize with other genera in nature, hence the ancestry is not surely known. The

wild species are restricted to South Asia and Indies. They have been transported by man for thousands of years and were found by Captain James Cook on Tahiti in 1773. Sugar was made in early India and imported by Romans, but the cane itself was eventually taken to places in the warmer Roman Empire, where it reached Spain by 900 A.D. and was taken by Columbus to the New World on his second voyage (*Cana Criolla,* i.e., "Creole" or "Cane of the Country").

Sugar as a food was scarcely appreciated before the middle of the 17th Century in Europe, although its use as a sweetening agent in sauces for foods was mentioned in the 11th Century by Arnoldus, and of course, in early India. Prior to the discovery and use of sugar (18th and 19th Century commercially) it was used chiefly as a medicine, P. S. Pittenger (1947).

Both sugar and dextrose pass through the mouth without change, because the saliva is not acidic and does not contain enzymes capable of bringing about inversion. In the stomach, dextrose remains unchanged and little, if any of it, is absorbed through the wall of the stomach. Sugar, however, begins an inversion in the stomach in the presence of the acid gastric juice. Ordinarily, sugar is rapidly cleared from the stomach so that the inversion which occurs there is only partial.

Sugar passes from the stomach into the small intestine somewhat more quickly than dextrose, but the small difference in time can not fairly be considered to give either substance any appreciable practical advantage. In the small intestine any sugar which has escaped inversion in the stomach encounters invertase, or some similar enzyme, which completes very rapidly the process of splitting it into levulose and dextrose.

It is in the small intestine that the main absorption of levulose and dextrose into the bloodstream occurs. Two entirely separate processes of absorption are held to take place. The first of these is a slow, nonspecific type of absorption by diffusion. Not only levulose and dextrose but all other simple sugars are probably absorbed slowly by this process. The second and much more important type is specific absorption, involving combination with phosphoric acid. This is five to 10 times as rapid for those particular sugars which, like levulose and dextrose, are capable of being absorbed in this manner, and by this process dextrose is absorbed somewhat more than twice as fast as levulose. The speed of this type of absorption by phosphorylation is practically independent of the concentration of the sugars in the intestine, unless that concentration is below 10 per cent. Thus dextrose will be absorbed into the blood at the same rate from the intestine, whether it is present alone or with levulose in a mixture such as is formed from sugar.

Perhaps the most striking fact about the behavior of ordinary sugar in the body is the speed with which it affects the level of blood sugar. In spite of the fact that sugar is a double molecule that has to undergo inversion before absorption, recent studies have shown that sugar taken by mouth may increase the blood sugar more quickly than either levulose or dextrose taken alone, or a mere mixture of levulose and dextrose. Within one minute after sugar has been taken by mouth, it may be reflected in the bloodstream. These observations suggest that the mechanism of the process is still not fully understood, but they point to the fact that sugar is more than a mixture and has unique physiological behavior.

Sugar, together with fat and protein supplements, furnishes a valuable ingredient for tolerance to cold. Once levulose and dextrose have been absorbed into the capillaries of the intestinal wall, they are carried directly to the liver by the portal vein. There they are both converted in part to glycogen (animal starch)—a substance which functions as a reserve carbohydrate in animals—and in part directly to fat. This reserve glycogen is changed into dextrose and is fed into the bloodstream as needed, to keep the blood sugar within its normal limits as this is distributed to the various organs and muscles to meet the fuel demands of the body.

Early man showed some interest in the sweet honeystone, or mellite, which still occurs in massive nodules in Thuringia, Bohemia, Moravia, European Russia, Siberia, and the Transbaikal regions. The acid, mellitic acid $C_6(COOH)_6$, usually occurs in the form of the aluminum salt. Primal folk were and are inordinately fond of honey, the bees and bears being strong competitors. Disasters from eating poisonous wild honey, like the poisonous honey of Xenophon, are often noted. Xenophon tells of a food-poisoning outbreak among the Ten Thousand after they reached the Black Sea. The soldiers camped in some mountain villages which they found well-stocked with food and honey and observed great numbers of beehives. All the soldiers who ate of the honey became delirious and suffered vomiting and diarrhea. "They lay on the ground as though after a defeat." Luckily, they recovered the next day "about the same hour as they had eaten the honey the day before; on the fourth day they were well but felt just as if they had been taking medicine." These honeys were derived from the nectar of poisonous flowers like *Rhododendron ponticum,* mountain laurel, *Datura stramonium,* and *Gelsemium.* Maple syrup and maple sugar were a gift from the Amerinds of northeastern America. Schuette and Schuette (1935) have covered the history of maple sugar for the student. Manna of both plant and animal

sources [described by S. G. Harrison (1950)] was and still is used for sweetening and for making sweetmeats in Asia Minor.

Notes on Eating Habits

The influences of nutrition upon mental processes are becoming better known through the work of many nutritionists, biochemists, and psychologists. We need not ride the hobby to the extent practiced by the noted British actor, Edmund Kean, who altered his diet to suit the role he played. He ate pork for a tyrannical part; beef for a murderer; and mutton for a lover! We entered into the controversy over vegetarianism *vs.* meat eating elsewhere, Jensen (1949), and came into hearty agreement with Drummond and Wilbraham (1939), who believed that most people thrive on a mixed, balanced diet, although some find themselves better by abstaining from meat, while others find a wholly vegetarian diet "conducive to little else than a sense of frustration, and wind."

Investigation by Poulsen (1950) of Seventh Day Adventists living on an ovo-lacto-vegetarian diet (pork, alcohol, spices, and stimulants prohibited), for cancer morbidity, disclosed an increasing tuberculosis morbidity among women 15 to 44. The disease occurred chiefly in persons who had been members of the community for many years. A large number of cases had a rapid course and were promptly fatal in adolescence. Diets poor in fat, probably poor in available first-class protein, lead to the assumption that the increased tuberculosis incidence was caused by insufficient protein for antibody production, as well as by a diet low in calories.

When Occidentals refer to meals they say "meat and other foods." Meat is always mentioned first, but in the Orient, rice comes first. As we have noted, each human being has a metabolic pattern which differs in numerous respects from others in his group and as yet very little progress has been made in diets that are universally good, i.e., good for every one. Roger J. Williams (1946).

Man has been selected through faulty nutrition, but his goal will be towards ideal nutrition when and if global strife ceases. Ideal nutrition will vary for the individual. We recall Ghandi's "passionless" diet for mental activity of a benevolent nature, as opposed to Bismarck's gargantuan intake; the Asiatic rice eaters whose nitrogen equilibrium has been established by the long millennia of rice eating; the basic foods for various climates; and the dietary of earnest professional athletes. Obviously no one will eat his way into the Kingdom of Heaven, but behavior patterns appear to be influenced by good and bad nutrition.

Herodotus quotes Cyrus, the Persian king, "Soft countries give birth to soft men—there was no region which produced very delightful fruits

and at the same time men of a war-like spirit." Dr. Morris Fishbein (1937) finds no correlation of food with fierceness. The four most vicious animals known—gorilla, bull, rhinoceros, and bull buffalo are vegetarians. However, the carnivores are not lacking in fierceness, and God's creatures who eat a mixed diet usually fail in the ways of peace.

One can estimate the amount of food eaten by a 70-year-old American of average income as about 1,500 times his weight. He will have ingested a quarter-million pounds of meat—beef, pork, sheep, and fowl—along with two or three thousand pounds of fish, 35,000 pounds of vegetables, including grain and fruits, 33,000 quarts of liquids, as milk, coffee, and beer, as well as an additional three thousand gallons of water, a half-ton of common salt, 4,000 to 6,000 eggs, 6,000 pounds of sugar, and a thousand pounds of cheese and dairy foods other than milk. Accessory foods, trace elements, and condiments are numerous indeed. The body (and race) viewed as a machine or as an enzyme apparatus must surely be profoundly affected by foods in time and space, especially up to and during the reproductive period.

To fill in lacunae Herodotus often ended a description with " . . . whereof it is not lawful to speak . . . " especially when dealing with familiar and foreign gods. So, too, we do not deal with spiritual values and regretfully refer the reader to Dr. T. E. Lawson's calculations which show that an average adult man in chemical terms represents:

Enough water to fill a 10-gallon keg
Fat for seven bars of soap
Carbon for 9,000 lead pencils
Phosphorus for 220 matches
Magnesium for one dose of salts
Iron to make a nail
Lime to whitewash a chicken coop
And sulphur enough to rid one dog of fleas.

Commercial prosperity and great wealth of a country pave the way for greater freedom in choice of foods and greater variety of animal and vegetable foods. Methods of preparation for eye appeal and palatability stimulate appetite and dietary habits, and customs thus change accordingly. The one thing that primitive, barbarous, and civilized man (except the classic Greeks) have longed for alike is an abundance of the "flesh-pots of Egypt."

Habits and cravings are certainly very unreliable indices of true physiological requirements. During the last four centuries many thoughtful men have called attention to the apparent excessive use of food. Now we need more than temperance. We need the adequate balanced diet!

Dr. Thomas Cogan in 1596 wrote to the Earl of Hertford, "Use a measure in eating, that thou maist live long: and if thou wilst be in health, then hold thine hands . . . This disease, I mean surfet, is very common: for common is that saying and most true! That more die by surfet than by the sword . . . 'if you would be free from physicians (Salernus says), let these three be your physician, a cheerful mind, rest, and a moderate diet.' "

Louis Cornaro, the Venetian who in 1556 published his book, "The Temperate Life," the last edition of which was published when he was 95 years of age, followed his own admonitions, but modern writers were slow to appreciate the grave consequences of intemperance.

So much for overeating, which still leaves the question of hollow hunger *vs.* hidden hunger—hollow hunger in the starving, and hidden hunger in the obese and others who eat the wrong foods or too much of all foods.

Beginning with want, and then in Holocene times with superstition and taboos, man often lost good nutrition. The literature is replete with incidents illustrating the point. A characteristic picture was afforded by the fate of six Russian priests and a boy servant who some years ago arrived at Yugor Straits in the fall. Because of religious vows the priests would not eat meat, but subsisted on salted fish, there being no vegetable foods to be had. The lad survived but by the next May he had buried his six masters in the snow. The unscrupulous boy ate fresh reindeer meat all through the winter. Benedict (1915), the great American nutritionist, observed, "Prolonged fasting, a part of religious ceremony for centuries, led the ascetic by this means to hope that freedom for spiritual and philosophical introspection might result!" Fasting was often resorted to in order to cure an illness, or as atonement for remission of sins.

Today our world has chronic hunger. There is not enough food for all the two billion men, women, and children. Some folk have always been hungry, but in those areas, too, where death due to starvation is a commonplace, there has been lavish waste. Three-fourths of the world live as poorly as their grand-parents, and are almost unaffected by the great technical advances of agriculture and manufacture. In this connection we should look closer at our country's wastage. Dr. S. B. Freeborn (1952) writes, "Weeds and plant and animal diseases caused a loss of \$13 billion in 1950. This loss of production had a total dollar value of \$31 billion, or 46 per cent of the 1950 gross agricultural production. Scientists agree that a great part or all of these losses could be averted by systematic and comprehensive use of insecticides, fungicides, rodenticides, and herbicides."

However, study of food habits shows a surprising array of disliked familiar foods, as well as fear of new foods. Whereas the accounts of the sturdy American pioneers are rich in food acceptances, Dr. Rubner, the great physiologist, observed that an emigrant tends to forget the language of his fatherland before giving up his native food habits. An old German saying "What the peasant does not know, he does not eat," must have been observed by Herbert Hoover in his food distribution problems on the Continent in World War I days. The American pioneers and finally Old World peoples accepted from the Amerinds our now important foods, corn, potatoes (Irish and sweet), tomatoes, beans (kidney, lima), squashes, turkeys, cocoa-chocolate, peanuts, wild rice, maple sugar, pumpkins, avocados, pineapples, cashew nuts, vanilla, chili, and strawberries and oranges (Cortez), not to mention 3,500 different species of plants known to have been used by the Indians either for food, beverages, fibers, medicines, dyes, or utensils. Nearly one-half was used for food, Wittrock and Wittrock (1942). It has been observed often that homesickness of soldier or emigrant is influenced by lack of familiar foods, and one of the best ways to keep soldiers happy is to provide them with familiar foods and confections. On the other hand, certain canned luncheon meats of excellent protein quality which were constantly consumed in World War II led to the condition treated in Kurt Lewin's general law of psychological satiety. American soldiers have another name for it. When Malta was close to starvation during a phase of World War II, people threw dried, powdered eggs into the streets rather than eat them. Rice-eating Hindus, during the great famine, died rather than touch the millet given them by relief agencies. James Fenimore Cooper (1845) writes in the "Chainbearer," "Give me children," says the frontiersman's wife, "that's raised on good sound pork afore all the game in the country. Game's good as a relish and so's bread; but pork is the staff of life!" Those readers who are interested in the problem of dietary change and social process, and the general problems of changing food habits in America may obtain full information in Bulletins of the National Research Council (No. 108, 1943 and No. 111, 1945).

We have noted prehistoric man in the Old World had already searched the whole of nature for comestibles, and there may be a phylogenetic reason for disliking some unknown food; it may be ingrained in man from pre-history, although hardheaded laboratory scientists, with justice, pay little heed to conjecture.

Early in the 19th Century North Carolina sent over to England the tomato, or love-apple, considered by authorities to be a violent aphrodisiac. By 1880 the tomato was offered for sale in most fruit-markets.

About 1900 an absurd story of cancer resulting from tomato eating became current, which some older-generation Europeans still believe.

The history of food acceptance the past 400 years is a complicated study in itself. Inkshed and violence went hand and hand with acceptance of potatoes, corn, and tomatoes in Europe, and understandably so, when one considers the one- or two-foods dietary of the emerging peasant. Corn needs dietary supplements and the disastrous effects on Latin European populations are pathetically featured in medical records. On the other hand, potatoes proved to be very good food in Ireland, Germany, and Scandinavia. A. J. Carlson and F. Hoelzel (1950) had much to say about effects of rich, bulky, and poor diets. They asserted that bulky diets were best. Low fertility of high-grade livestock and human upper classes may be due to use of too much rich food and delayed procreation in successive generations. In their presentation of the paper, the authors called attention to the original suggestion made by the British philosopher, Herbert Spencer, a century ago, that good food may cause human beings to be less fertile. Spencer attributed the high birth rate of the Irish and the lower birth rate of the English to the fact that the English had a better general diet. In fact, the Irish folk instinctively ate a balanced diet when not oppressed and when their foodstuffs were not confiscated.

Previous laboratory experiments with experimental animals in the United States had tended to disprove Spencer's theory. However, in Professor Carlson's experiments, the diets, while rich by laboratory standards, were not comparable to really rich human diets.

In the eastern Asiatic areas where polished rice is a main article of diet, the majority of native people shows short stature. The northern Chinese are often tall. When children of folk of these genetical pools are studied in North America, their increase in stature is striking. Adaptation to a polished rice diet has been successful there, and fertility, as Carlson suggests, may be greater as a result of diets less rich in proteins.

There is reason to believe that approximately correct nutrition, when it is learned, will determine man's place in future history. Life histories of experimental animals have shown to a surprising degree the influence of proper nutrients on a diet formerly regarded as entirely satisfactory, both by the animal in its native habitat, and by man, its domesticator. Can this type of knowledge be applied to man? There is good reason to expect much from correct nutrition.

Shakespeare's warning is classic,

> "Make less thy body hence, and more thy grace,
> Leave gormandizing, know the grave doth gape
> For thee thrice wider than for other men."

There is a difference between adequate and optimal nutrition. Improvement of the nutritional status not only brings about varying degrees of resistance to diseases, but "adds years to your life and life to your years." The period of "prime" is lengthened and onset of senility may be delayed. Nutrition as well as heredity is an important factor in longevity. We cannot choose our parentage, but we may choose our foods, if we have money in pocket.

The improvement of health and physique of the peoples of many of the better-fed occidental nations is now a matter of record, H. C. Sherman (1950).

Dr. James S. McLester, in his presidential address to the American Medical Association, observed that the newer knowledge of nutrition offers greater vigor, increased longevity, and a higher level of cultural attainment, which means that man must do more than escape nutritional deficiency diseases.

Even though a people in a certain geographical area seem to have reached equilibrium with their environment, the observed fact of survival is not proof that their food is nutritionally satisfactory. Too often "racial inferiority" is a matter of nutrition functioning at low levels, far below the level of full cultural and mental capacities. Sudden efflorescence of such a folk might result from wealth in the domain of nutrition. Rising incomes, with increased consumption of meat, milk, eggs, fruit, and certain vegetables have gone hand-in-hand with improved general health, decreased death rates, better growth of children, and improved adult physique, including stature. Likewise, mental growth or accomplishment, although not easy to measure, seems to go hand-in-hand with best nutrition. The body can make good use of surpluses of some nutrients, notably vitamins A and C and calcium.

It does not require any great amount of historical acumen to realize that civilizations and cultures either decay, succumb, or become stronger according to intelligence and judgment in meeting conditions. It is a fact, however, that democracy has never existed in a country where there was not an adequacy of food. It is difficult to predict how important in the history of mankind the newer knowledge of nutrition will be when applied, for it is a factor quite different from all of the others. Other factors, when introduced, produced improvements that could be seen readily or understood by almost everyone, as far as convenience, safety, and delight in eating were concerned. However, applying the knowledge of nutrition to eating is, to most people, troublesome and of no immediate or obvious value. The results of good nutrition are not too apparent to most of us.

We cite an illustrative case for proteins and well-being from Dr. Graham Lusk (1928). Dr. Lusk, dealing with the status of proteins in human nutrition, recalled crossing the English Channel with Professor Chittenden on March 18, 1918. Both men had lived in England under the "austerity" of that period. On the navy transport they were given a large cut of roast beef which they ate with delight and satisfaction. Lusk attributed his sensation to the "improvement quota" of his protein stores, while Chittenden attributed the result to the stimulation of appetite by the sea-air.

Often there is little relation between nutritive value and prestige, as can be surmised when good children are rewarded with candy, ice-cream, and desserts denied "bad" children.

Soil, Minerals, and Human Nutrition

One hears much of soil fertility affecting human nutrition. While there is no doubt that soil fertility greatly affects crop yield, there is a paucity of data concerning the effect of soil fertility upon nutritional quality of foods and upon human health. With the exception of iodine, and iodine deficiency resulting in goiter, no other direct relationships of importance have been established between deficiencies of minerals in the soil and human nutritional troubles resulting from these deficiencies in food, although speculation has been and is rife. The reason for this lies obviously in the almost insurmountable complications attendant upon longtime experiments with human subjects. Long-range observations of isolated communities dependent upon their own produce might show the answer, if such isolates could now be found.

Fertilizer practices have engendered controversial ideas in two respects. First, does any nutritional benefit other than improved mineral content of the plant accrue as a result of fertilization? The evidence, that has been presented in the literature for a change in the amino acid composition of the plant protein as a result of fertilization (except nitrogen), is not very convincing. The second controversy of recent interest is the attack on commercial or "chemical" fertilizers by proponents of organic fertilizers. As in other appeals made to popular prejudice, little, if any, real evidence is offered to support the contention that commercial fertilizers result in nutritional troubles of any kind in man and animals.

In 1927, the classic inquiry, "Minerals in Pastures" by Sir John Boyd-Orr showed the critical role of soil minerals in nutritive value of pasture herbage and in the health, fertility, and growth of domestic animals. Boyd-Orr expresses this basic soil-plant-animal relationship as

follows: "The rate of growth of the young, the percentage of fertility, and the health are roughly parallel with the percentage of 'silica-free ash,' which represent total metabolizable minerals."

Soil decadence and pristine deficiencies of soil are obvious entities not to be confused. The bounty of Mother Earth is removed with each crop. Animals are dependent ultimately on plants. The influence of the soluble minerals of a terrain upon types of plants and animals has been the subject of much discussion and controversy. The outcropping of strata of various geological ages has certainly furnished a selected mineral intake for various peoples of the same ethnic compost.

The bulk minerals, calcium, magnesium, phosphorus, sodium, potassium (and chlorine), sulphur, and the trace mineral elements, iron, copper, iodine, manganese, zinc, and cobalt are required by the animal body. Other trace elements: fluorine, aluminum, boron, molybdenum, bromine are apparently not essential for growth. Strontium, nickel, arsenic, rubidium, vanadium, thallium, and barium may also be found in traces, but their function is not clear.

Copper deficiencies have never been recognized in man, although in black-haired rats greying of the hair results when the diet is free from copper. Interrelationships of copper metabolism with molybdenum, iron, manganese, cobalt, and zinc seem indicated in studies on livestock nutrition.

Lack of cobalt, a part of the vitamin B_{12} molecule, does affect animals profoundly, but cobalt deficiency has not been reported in man. Fluorine in the diet decreases incidence of dental caries, but an excess causes mottling of teeth. Manganese deficiency is likewise not known in humans, but soils deficient in this element affect animals. Zinc is associated with several enzymes. Carbonic anhydrase found in brain and red blood cells is a zinc-protein complex. Deficiencies are not met with in man, but test cattle become sterile on zinc-free feeds, H. Van Goor (1948).

A. L. Lehninger (1950), reporting on the role of metal ions in enzyme systems, finds more than five classes of metalloenzymes of cell metabolism which direct the chemistry of the body.

The role of calcium, and interrelationships of vitamin D and ascorbic acid, in building bone and teeth and in blood chemistry, and the role of phosphorus in its combination with calcium, together with 14 vital processes of phosphorus involving metabolism, blood chemistry, muscle, skeletal and tooth development, enzyme and vitamin activity, and muscular contraction, need not be gone into here. Good sources of phosphorus include meat, milk, cheese, eggs, and cereals. Important sources of calcium are dairy foods, egg yolk, green olives, turnip greens, broc-

coli, kale, and dry beans. For instance, the peoples of the Near East and the Arabian folk were well provided with available calcium from olives, a richer source than milk. Dr. H. Schultz pointed out that the Nilotes of the Delta ate wheat with fish supplement, the valley folk, wheat with dairy supplements, and that the Bedawin of the deserts also ate wheat with dairy supplements, together with olives, fruits, meat, and barley-wheat beer.

F. A. Gilbert (1948) classifies elements used in nutrition as Essential, Unessential, Energy Elements, Macronutrient, and Micronutrient. There are 60 elements in plants, 20 of which are essential. The toxic elements are selenium, fluorine, arsenic, mercury, and lead. The iodine-deficient soils of the Great Lakes regions, Crete, Pacific Northwest, Himalayas, Pyrenees, Andes, and the Alpine regions are historical in their incidence of goiter, and iodine deficiencies.

The pituitary-thyroid axes function together by pituitary secretion stimulating the thyroid gland, and in turn thyroid secretion can stop or inhibit pituitary secretion. When iodine is ingested in iodine-rich foods, oysters, salmon, tuna, or iodized salt, it is absorbed by the thyroid, and thyroxine, a hormone, is manufactured, which carried in the bloodstream produces striking effects in many parts of the body, controlling rate of heat production by controlling the rate of cell oxidation (basal metabolism). The thyroid stimulates normal growth of bone, hair, and skin; the normal development of the brain; and sexual development at puberty; it maintains normal pregnancy and aids in production of milk during nursing. Simple goiter, cretinism (dwarfed during foetal life), and myxedema come about through lack of thyroid secretion. Increased function, or an overactive state, causes toxic goiter, W. H. Sebrell (1949).

Some soils of the world contain large quantities of nitrates and nitrites which gravely affect cattle, and human infants who are given certain well waters in their liquid formulas.

The mineral concentrations of the drying soils of Hither-Asia after the Pluvial period may have been a factor in nutrition of these early food producers. V. Gordon Childe (1935) speaks of the evil effects of lime hunger in the old igneous rock areas of Scotland, and he observes concentrations of prehistoric settlements in the few areas where limestone outcrops, as in Ayrshire. The shell in seasands provided a source of calcium in the Scottish-Norse Islands, eastern seacoasts, and raised beaches. Calcium has been shown to be important not only for the rigidity of animals and cells, but also as the prime instigator of vital activity, L. V. Heilbrunn (1951). Although much has been written about the need of

humans for most of the minerals mentioned here, today (1952) we cannot profitably pursue the subject further for lack of clinical evidence or failure to recognize mineral deficiencies. Most or all of the elements listed may be as important in their specific functions as calcium, phosphorus, sulphur, iodine, cobalt, zinc, copper, sodium and potassium (chlorides), magnesium, and manganese.

Xenophon's *Oeconomicus* was a standard book on scientific agriculture and enrichment of soils with animal and mineral fertilizers.

The custom slowly supplanted the fallow second year. In addition, rotation of crops began with a fallow third year. Greater crop yields and better quality were noticeable.

Common Salt (Sodium Chloride)

Carnivorous animals, and people like the Eskimo who do not eat much vegetable matter, do not crave salt but rather abhor it. Salt is used by those folk who subsist largely on vegetable foods, and as the latter have a potassium content, sodium in sodium chloride is needed to replace potassium in the body. In all climes people who sweat a great deal need salt. Some clinicians feel that most Americans ingest too much salt.

Hunters in the pristine American forests and on the plains knew that herbivorous ruminants and hooved creatures were attracted to salt-licks, whereas carnivores were not attracted by the salt and other minerals, but rather by the presence of the salt-hungry animals. These "salt licks" supplied water and probably also supplied needed mineral supplements of salt, calcium, phosphorous, magnesium, sulphur, and trace elements.

Salt-free, or rather sodium-free, diets are now widely employed in treating certain diseases and in reducing the weight in the first stages of treating obesity. Loss of body water results in an astonishing degree to a certain point on low sodium polished rice-raw tomato diets. About 80 years ago, Dr. G. Bunge, the great German physiologist, showed that feeding potassium salts to humans lowered the content of sodium, and vice versa. Foods rich in potassium, like cereals-vegetables, or added chemical produced "salt hunger" more quickly than foods poor in potassium, like meats. We can see salt hunger in peoples of classic antiquity and as most people know, our word *salary* came down to us from the Latin, *salarium,* or allowance for salt. The terms "worth his salt," "salt of the earth," etc., are the philologic fossils of long ago, when Caesar's legions in Gaul and elsewhere refused meat when wheat was to be had. Salt through man's history, beginning with the invention of agriculture, has been one of the most important items of barter. The salt mines of

Hallstatt of the early Iron Age (900 B.C.) and the salt traders are mentioned by V. Gordon Childe (1948b) in the dawn of European Civilization trading with the peaceful Danubians of Cultures I and IV of the early Bronze Age. These Danubians, as we have seen, were almost entirely cereal farmers and did little or no hunting. They would obviously need salt in their grain diets. Curiously enough, Hitler derived his Swastika symbol from the swastika and sun disk marks of these early Hallstatt salt miners, whose site was near his home in Austria.

The ancient Mesopotamian personified salt as a fellow-being with special powers and addressed it, "O Salt, created in a clean place for food of Gods did Enlil destine thee, without thee no meal is set out, without thee god and potentates do not smell incense." Lake Tatta in Asia Minor furnished salt for the later Hellenistic world.

Water

Water may also be thought of as an essential nutrient, yet food is not ordinarily thought of as a source of water. However, many fruits, and of course fluid foods such as milk, contribute appreciable amounts of water to the diet. If it were necessary to affix any "Number 1 position" to nutrients, it would be to water, for it is possible to survive considerably longer without food than without water. To emphasize its importance, it is only necessary to point out that about three-fourths of the total body mass is water.

According to biochemists, water is a food, even though it does not supply energy as do carbohydrates, fats, and proteins. Food is considered as including all materials required for growth and repair of body tissue, and water is certainly one of these.

Water is classified as an inorganic mineral substance. Living matter contains from 70 to 80 per cent water. Most foods, with the exception of fats, contain from 60 to 95 per cent water. Loss of 10 per cent of the water content of the body results in serious disorders, while a loss of 20 per cent results in death. By contrast, a fasting animal can use up almost the entire supply of body fat and half of its protein before death results. Death results not from an actual deficiency of water *per se*, but from a disturbance in the electrolyte balance (salt concentrations) of the body fluids. Water is needed for the blood, lymph, gastro-intestinal secretions (saliva, gastric juice, bile, pancreatic, and intestinal juices), and intracellular fluid. Water is lost from the body in the urine, saliva, feces, tears, nasal secretions, sexual secretions, milk secretion, vomitus, and by evaporation from the skin and lungs. All the reactions of cellular metabolism take place in a fluid medium. The presence of various

mineral salts in solution in the blood, lymph, and intracellular fluids is essential for the normal performance of all vital cellular activities.

Water-borne diseases are not frequent with primitive nomads. When one considers their untreated raw water supplies, the low incidence is noteworthy. Settlements lead to all water-borne diseases, bacterial, protozoal, and helminthic. Nomads often break camp when the environment is no longer suitable for game, pasturage, or becomes rather befouled. Primal man drinks like the anthropoid ape, i. e., bending down to the water source and sucking water, if his nose is not too prominent, or making a receptacle of his cupped hands. Certain Australian tribes used hand-lapping, i.e., shooting water from the surface with remarkable accuracy into the opened mouth about a foot from the source of supply. Some used sucking-reeds or straws. Primal man, like the animals, does not often drink with his meals. The Australian aborigines, as well as the Fugeans, drank large quantities of water to relieve indigestion or to reduce fevers. They preferred hot water for their therapeutics, if they could get it.

In contrast to the historical past, the conservation of natural resources is one of the important problems of today, and stream-pollution control is a part of this program. The idea of streams and rivers of pristine purity in populated areas since the Neolithic has long been abandoned. It is more than likely that Nomadic invaders and other invaders from lands with uncontaminated water supplies when coming to Mesopotamia, India, or Egypt experienced high mortality rates from enteric diseases. With the rise of applied science, it was found long ago that in populous areas water of rivers and lakes could not be used as safe, potable supplies without treatment. The first steps in water purification were probably taken in China and India thousands of years ago, H. E. Babbitt and J. J. Doland (1949). For centuries the Chinese put alum in tubs of water to clarify it and this practice was observed in Egypt (Water, August 15, 1905). In the "Ousruta Sanghita," a Sanskrit medical treatise (2000 B.C.?), is taught "keep water in copper vessels, expose it to sunlight, and filter through charcoal!" In the earlier Ayura Veda, it is directed that one must boil foul water, expose it to sunlight, and then dip a piece of hot copper in it; filter and cool in clean earthenware. These practices were as modern as one could wish, so far as purification went, and everyone knows that our knowledge of bacteria and disinfection is recent indeed. Of course, uncontrolled dumping of wastes into rivers and lakes may soon result in an economic and aesthetic loss to a community. Sanitary engineers generally believe that some middle ground must be established where economy, utilization, and aesthetics may reach a proper equilibrium.

Practically everyone interested in these problems agrees that streams have the property of self-purification. The power of running water to destroy or oxidize domestic and industrial waste is a most interesting phenomenon in nature. Man in his studies of the microorganic life in water has learned certain fundamentals of "potomology," defined by Dr. E. B. Phelps (1944) as the science of rivers, which trespasses on practically every field of science.

The origins of man's study of "potomology" are lost in antiquity. The 26th chapter of Genesis reads like a water-supply paper. Those great engineers—the Romans—everywhere had an eye for disposal of wastes by dilution into streams. Their cultural predecessors, the Persians, dug tunnels and "kanats" for disposal of waste and procurement of water. Some 36 of these ancient tunnels supplying modern Teheran are eight to 16 miles long and reach a maximum of 500 feet below the ground surface. Wendell L. Willkie, in his "One World," quoted an old Persian phrase current these many thousand years, to the effect that "when water turns over seven times it is purified." Years ago we said that water in rivers purified itself every seven miles of flow. Nowadays we still say "running water purifies itself," but we have more facts at hand.

Self-Purification of Streams

Various natural influences combine to purify running water: (a) physical, some of the most important of which are aeration, light, gravity; (b) chemical, outstanding among which are oxidation and reduction and coagulation; and (c) biological, principally the action of microorganisms on the wastes serving as foodstuffs for them.

It is known that river and lake waters in contact with the atmosphere absorb oxygen, and when oxygen is absorbed, gases of decomposition, such as carbon dioxide and marsh gas, or methane, are liberated from the water. *Absorbed oxygen* is of the greatest importance and the chemist calls this D. O., or "dissolved oxygen." The D. O. of water determines its efficacy to purify the waste substances in it. The oxygen required of waste substances to be purified is called B. O. D., or "biological oxygen demand." For instance, the B. O. D. of domestic sewage per capita per day has been established at about 0.167 lb.

Sunlight may aid in bleaching color in water, but its greatest effect is stimulating photosynthesis in aquatic plant life, so that oxygen is added to the water and carbon dioxide is removed as food, just like our household plants utilize the carbon dioxide of our breath and give off oxygen. The plants in water also utilize soluble foodstuffs from the

wastes. Sunlight exerts a germicidal power upon all surface waters, depending upon turbidity and color of the stream.

Gravity manifests itself by sedimentation of coarse, suspended materials and smaller particles that have clumped together. In muddy streams like the Missouri or Mississippi, the water is cleaned in much the same manner as snow clears the air. The particles, as they settle like snow, tend to remove the bacteria as well as some of their food from water. When the engineer adds coagulating chemicals like aluminum sulfate to water supplies, he utilizes this principle, which is in effect forcing a filter to move through the water. Otherwise, the filtration engineer forces water through a filter.

Oxidation diminishes the amount of food for many microorganisms and also aids friendly bacteria to digest wastes, so that eventually the wastes are mineralized. Chemical analysis shows a rapid decrease in organic matter and an increase in nitrates. This reaction led chemists to conclude that running water soon purified itself. Some of us will recall when Theodore Roosevelt and Jacob Riis, in working their reforms in New York, became so very perturbed in finding that their water supply from the Hudson contained nitrates.

Reduction of sediment in rivers and lakes may take place where oxygen is not present and results in splitting organic compounds so that they are prepared for subsequent oxidation.

Biological forces bring about a cycle of changes in rivers by which wastes are broken down by bacterial action. The bacteria, if unimpeded, will multiply into such great numbers that our arithmetical calculations are, we trust, above suspicion. But even if, like the renowned Chancellor of the Exchequer of England who "never knew where the damned dots went," we worry about large numbers, we discover that protozoa or larger organisms devour bacteria so that our mathematical veracity remains unsullied. The single-celled protozoa are eaten by crustacea and rotifers, and these in turn are devoured by fish. In this way natural streams succeed in cleansing themselves so that waters once containing wastes become clear and attractive in appearance.

Ward and Whipple (1918) give an excellent illustration of these biological changes in the Genesee River, below the city of Rochester. The river received its waste of the city at a point about six miles distant from Lake Ontario. Studies showed that the effect of the waste was to increase the number of bacteria and reduce the number of green algae. Immediately below the outfall of the waste, there was a further increase in bacteria and a reduction of dissolved oxygen in the water. A mile or two downstream, the bacteria began to decrease, and protozoa and oxy-

gen increased. At the mouth of the river, the crustacea were found in abundance.

Physical improvement of water goes forward in a series of zones, marked in streams by a succession of forms of life, recalling in reverse Jonathan Swift's lines:

> "So, Nat'ralists observe, a Flea
> Hath smaller Fleas that on him prey,
> And these have smaller Fleas to bite 'em,
> And so proceed *ad infinitum.*"

No natural water (except certain well and artesian water) is free of microorganisms. The many degrees of purity (or pollution) of natural water have their corresponding degrees of organisms present. Water from cultivated fields running into rivers may contain characteristic genera of microorganisms which are called soil flora. Bacteriological studies of river and lake water, and ice not contaminated by human wastes (domestic sewage) show generally the kinds of microorganisms found in soil. These are the bacteria which mineralize proteins, fats, and carbohydrates of wastes whether in soil, river, or lake. We think of microbes as agents of disease and death, yet without microbes, life would be impossible. All animals and plants are dependent on their never ceasing activities. This is best explained by the nitrogen cycle of nature. Man eats protein, a nitrogenous, life-giving food. Protein is derived from both animal and vegetable sources. The animal—the flesh, milk, or eggs—of which he eats, derived its protein in turn from vegetation, so that the vegetable kingdom is the ultimate source of all nitrogenous food of mankind. The animal kingdom is mainly destructive. It tends to break down rather than build up. It is true that some of the protein is built into tissues of man's body, but the greater portion of it is broken down into urea, uric acid, and other "waste" products. Soil plants and aquatic plants take this waste with carbon dioxide and build up both proteins and carbohydrates. Plants convert simple substances into complex. Let us begin with nitrate formed in rivers, lakes, and soil and trace it to plants, where it is formed into protein. If plants could directly use urea as their source of nitrogen we would have a very simple nitrogen cycle. There is a gap between the form in which nitrogen is excreted by animals and the form in which it is absorbed by plants. Neither plants nor animals can bridge this gap, but bacteria can. In the rivers and soil, we find these bacteria in huge numbers. For instance, in the first 12 inches of surface soil of a cultivated field, we find about one-half ton of bacteria to the acre! They wash into the river and some convert urea into ammonia, others ammonia into nitrites, and

yet others nitrites into nitrates. Both plants and animals die, and decay is due to another group of these bacteria, without which the earth would soon be encumbered with the ever accumulating and never altering bodies of living things.

Bacterial Self-Purification

The bacteriologist who stands guard over our potable water supplies has his own special interest in bacteria. His interest is of quite a different character from the processes we have dwelt upon thus far. There are bacteria in the intestinal tracts of man and animals that are common to their discharges. They are called "colon bacilli" by the water bacteriologist, "coliform bacteria" by the British, "*B. coli*" by the medical profession, and "*Escherichia coli*" by the academic bacteriologist. Wherever these microorganisms are present, it is assumed that fecal pollution has taken place. Hence, they are indicator microbes of more or less value to sanitarians, who believe that typhoid organisms may be present also, since *Eberthella* (Salmonella) *typhi* and other enteric bacteria have the same habitat.

The colon bacilli do not appear to multiply after discharge into streams and the typhoid bacilli die at a rapid rate, even in the presence of such an abundant food supply as is found in our Chicago Drainage Canal. The late Professor E. O. Jordan and his pupils at the University of Chicago, in their classic studies of the longevity of typhoid bacteria in streams, found them to die in three or four days in highly polluted water, but in Lake Michigan water they persisted from four to eight days. When Lake Michigan water was sterilized and large numbers were introduced, the bacilli might live 25 days, indicating competitive life in natural waters. Most students now believe that bacteria of intestinal origin found in streams tend to die out. This is bacterial self-purification and is a matter of food supply and competition from other life in natural waters. Dr. Jordan placed typhoid bacilli in collodion sacks and immersed the sacks under normal stream conditions. The sacks permitted entry of soluble foods but served to retain the bacteria themselves. Dr. Jordan, in preparing himself as an expert witness in the celebrated trial of St. Louis, and cities near St. Louis, *vs.* Chicago, determined many of the factors of bacterial self-purification. He was fond of relating one exploit carried out in the dead of night when he and his aides placed barrels of cultures of *Bacillus prodigiosus (Serratia Marcesens),* an easily identified scarlet pigment producing bacterium, on railroad flat cars, eventually dumping them in the Illinois River, which received Chicago's sewage. These red bacteria died out quickly as the stream flowed on, showing that cities downstream did not receive Chicago

bacteria. Most of the factors we talk about today like protozoa, light, aeration, etc. were either discovered or re-established from his work. But Professor Jordan always warned, "What is wanted in a drinking water is innocence rather than repentance." Up to his death in 1936, he taught that there is no wide-spread typhoid fever due to water supplies which meet present standards, but potable supplies should be treated so that we need not be confronted with potential hazards. Rivers receiving a balanced amount of waste, and used as a source of treated water supply, can and should be utilized, many authorities state, as a natural asset.

The Bible, as well as archaeology, shows that in the Ninth Century B.C., Israelite women no longer depended upon the nearest spring or stream for water, but that every house had its own cistern where the winter rainfall was stored for use throughout the year. Cleanliness and sanitation were rigidly practiced according to the Mosaic Law. W. F. Albright (1949) has proved by the evidence of archaeology that emphasis on personal hygiene and avoidance of bad food practices which spread diseases were their way of life. Cisterns were provided with settling basins for clarification of the water, even though the rainwater was collected from the roof-tops. The ordinary household actually lived in the upper story of their home, not the ground floor, which was used for storage and work quarters. Underground drains were found in all towns of the interior. The common people of an ancient Jewish village washed their hands before eating, and the taking of frequent baths was imposed by law.

In Rome a Commissioner and a board of curators of the water supply was appointed under the Caesars to supervise the nine huge conduits in constant use.

In 97 A.D. Sextus Julius Frontinus was made commissioner of waterworks in Rome by Nerva and has left us a brilliant treatise, De Aquis. He tells us that 441 years from the founding of the city, Romans drew their water from the Tiber. In his day nine aqueducts conveyed water from far and near to the city: the Appian, Marcia, Old Anio, the Tepula, Julia, Virgo, Augusta, Claudia, and the New Anio. The New Anio possessed a settling basin. The Augusta water was unfit for drinking. Racketeers had tapped and plundered the Julia by branch pipes. Frontinus gives most of the plans, calculations, and descriptions in use today and dwells on the ajutages, the nozzles which assist in calculations of delivery of water (water meters). He states "when less is found in the delivery ajutages and more in the receiving ajutages, it is obvious that there is not error but fraud." He also dwells on the benefits which pure water confers upon mankind.

The oldest, the Aqua Appia, built in 312 B.C., was mostly underground and 11 miles long. As conduits eventually had to extend for long distances to find powerful jets, arches were needed. The Aqua Julia, built in 33 B.C., was 15.5 miles long with half of the conduit on arches. Aqua Claudia (40 A.D.) was 46 miles long with 9.5 miles on elevated arches. Aqua Marcia and Aqua Anio novus from the Anio river are not much shorter. Water was distributed into the city according to well-thought-out engineering methods, and 130 collecting tanks, or reservoirs, were used for supply tanks. Only the top floors of five- or six-story tenements were without water. Rome's water supply and sewage system were not equalled until the early 20th Century. We have noted that the Greeks were inferior in their methods in this respect, for Strabo in Augustus' time remarked that his fellow Greeks could boast of artistic adornment of cities but the Romans rejoiced in a far better water system, better sewers, and better paving. However, the Athenians, and inhabitants of other Greek cities used conduits and aqueducts of unquestionable antiquity, although individual houses were not on the supply lines as in Rome. Athens' supply (springs, pools, wells, conduits, fountains) was supervised by a board of overseers, and Athenians appeared not to be seriously affected by any difficulty in satisfying their needs. For full information about Roman aqueducts the student is referred to E. B. Van Deman's "The Building of the Roman Aqueducts," Carnegie Institution of Washington, No. 423.

Primal man and animals slacken their thirst with water of pool, lake, spring, river, or stream. In the drying Hither-Asiatic lands pits and wells were dug, and wells of good supply determined not only man's fixed abode in the semi-arid and arid lands of the later Neolithic, but eventually, as the chancy art of water-divining became a needful work, man formed new settlements. The great importance of wells is brought to mind when we recall Jacob's well, now identified, the pools of Solomon, pool of Shiloh, and the old well in Orvieto, Italy, called St. Patrick's Well after 1527 A.D. The history of water (and ice) and its manifold influences on man's physiology, economics, and dispersion remains to be written.

Notes on Genetics

Man is more than the product of his genes. Intelligence is based partly on inheritance of normal structures of the nervous system, but experience and teaching and diet play important roles in development. Dominant genes like those for curly hair, brown eyes, brunet hair and skin, and other somatic characters, as well as recessive genes like albino

coloring and blondness, are all inherited according to simple ratios, but the "gene pool" of humans is complex indeed. Man's chromosomes altogether may contain over 30,000 genes, combinations of which are mathematically great in number. The human cell possesses 48 chromosomes, except the sperm and egg, each containing half of the child's heredity. It has been estimated that about 150 different genes are the architects of the eye alone. Since there are at least two genes for every trait, most humans resist genetic changes, and some undesirable traits can be buried.

Evolutionary species like the giant reptiles have survived or perished partly because of the genes they inherited, and possibly because of abrupt changes in food supply. Since enzymes are gene-controlled, defective genes mean defective organisms. The non-nuclear plasma-genes of the cytoplasm found recently in plants and microorganisms may in the future lead us to better understanding of cell genetics. Cytoplasmic inheritance may be the factor of evolution, after all, but knowledge of mechanisms of the interaction between these two components of the cell awaits research (Horowitz and Mitchell, 1951). Diverse environments—cold, heat, humid or arid plains, and mountains, seas, and jungles—with concomitant diverse foods—have caused a great number of responses by the cell and we see a huge number of species emerge through the evolutionary process (about one million species of animals and more than 270,000 species of plants). The nutrients necessary to maintain species from viruses to elephants, and man in the various environments of past and present, may prove to be the important factor. Evolution is a creative response to foods for endurance of life in various environments. If the organism becomes specialized too rapidly, it perishes. Climates change with concomitant changes in foods, and the once perfectly adapted creature perishes.

All animals have been specialized to greater or lesser extents in their environments. Evolutionary forms depend upon their adaptability to an available nutritional pattern, which, in turn, may or may not depend upon the genetical mechanisms now held to be operative. For example, the zoological garden feeding problems of a generation or two ago seemed insurmountable. Today nutritionists are well advanced in solution of these problems, which arise from abrupt changes of nutrilites and environment. The adaptable animals fared just as well in captivity, but the animals needing highly specialized diets did not thrive.

The human groups of the past were more sharply separated than now. Their foods were those indigenous animals and plants that could be eaten. With the coming of food-producing times, there was a marked enlarge-

ment of nutritional patterns, culminating in the great variety of foods available in trade-center cities of classical antiquity. Likewise, the gene pools of man grew larger, until today there are signs—dim though they may appear—of one ocean forming from genetical, nutritional, and cultural pools. In nation-making, ethnic types gradually diverge, but the trends discernible indicate that convergence may come about suddenly through world conquerors, or slowly through increased ease of transportation and communication, or proximity.

Man, who derived his unspecialized bodily characteristics from generalized mammals, has now, with his great specialization of brain, the power to make himself through the guidance of cultural forces. Unfortunately, he is inept in government and clever at destruction, which may bring about self-extinction.

Sir Arthur Keith's (1949) group theory of man's origin assumes that many thousands of small, inbred, isolated communities were carriers of genes, no two communities of which were alike in these closed societies of primal man existing for at least a half-million years. Inbreeding of defective genes would liquidate a group, but healthy genes, through inbreeding, would establish a genetical descent, speeding up the rate of evolutionary change. The fertility of the group would depend upon lethal factors in both heredity and nutritional environment. Individual and group selection went hand-in-hand. As the phenomenon of agglutination demonstrates, first a few bacilli or cells clump, then larger clumps form in specific serums, until the flakes are visible; after a time they coalesce into a precipitate, amorphous to the eye but particulate, nevertheless. That is the physics of community structure—a specific serum, complex withal, stimulated in a complex host, which in the test tube of heredity is acted upon by environment to coalesce specific units or isolates.

How these factors of the group theory have combined to bring about evolutionary changes can only be touched upon in the present work, primarily from lack of data. The ancient animal qualities of competition and the passions of envy, jealousy, emulation, and ambition led to both internal and external conflict, then as now, as we have seen in the order of the peck. But all was not evil, as Professor W. C. Allee (1938) states in his "Social Life of Animals," who found that in animals automatic cooperation is a fundamental principle of biology.

Dr. H. J. Muller (Nobel prize winner, 1946), during the past 25 years has proved heritable changes can be induced in animals and plants by subjecting their sex cells to various X-rays and chemicals. A voluminous literature now attests to the fact that chromosomal breakage is

involved, but the mutant genes involved control the lack or presence of an enzyme. Cytoplasm "houses" the genes and other cell inclusions for their functioning. It is obviously fortunate that gene control keeps biological nature in control.

The physiology of the cell, with its primary and secondary organizers and many more mechanisms, is not within the ambit of this book. Food furnishes the substances which are the continuous supply of modifying agencies of the cell. The development of organs takes place in the embyro before the function for which they are designed is in use, e.g., the complex eye is built long before sight. Sensation and consciousness are beyond the scope of present-day physics and biochemistry.

Assuming larger brain capacities were in the direction of survival and success, it is possible that matings of groups possessing these distinctions helped this trend upwards. While gene mutation occurs often, and may account for defects and stigmata, mutation was not usually invoked to explain human evolution until recently. Mutations are an absolute necessity for evolution, for they provide all of the raw material, W. D. Boyd (1950).

Posture genes differentiated the anthropoid stock by making the earliest progenitors a ground form, at no remote period as geologists reckon time, with unspecialized hands (and again on the thin ice of "plastic postural genes") and man could become a denizen of the inhabitable earth. He possessed specializations in mind and body, however, of certain fundamental activities: reproduction, care and nourishment of young, and protection of mother and child, Sir Arthur Keith (1949).

Keith, Polk, and others show that foetal characters are passed into adult life, i.e., hairiness in one stage, and that cranial and facial developments (roundheaded, high or low nasal bridge, crest formation) are dependent on endocrine, and ultimately on genetical influences activated and maintained by nutrilites. They lay stress on Mongolian facial characteristics of foetalization, low retracted nasal bridge, epicanthus fold, and protruberant eyeballs, which persist into adult life. These foetal characters appear in many Europeans and in the majority of Hottentots. Prenatal nutrition exerts a profound effect on well-being of the embyro and infant, which can extend under given conditions to old age. Roundheadedness occurs in early stages of foetal development in the great apes and man. As we have seen, roundheads are retained in many human ethnic units, and apparently brachycranes are steadily increasing in numbers.

Gamow's theory (1948) of race senility invokes Haeckel's biogenic law, "ontogeny recapitulates phylogeny." The principle of recapitula-

tion (exhaustion) results when species or races grow old. Cells of old stock "grow tired" of division, i.e., hereditary properties become diluted. Genetical exhaustion changes and extinguishes genera and species just like each of their separate members die. If this theory is not tenable it is interesting, because long existence on a given restricted food or group of nutrilites would tend to specialize the organism, but new environments and foods would in many instances exhaust or otherwise extinguish the organism.

For instance, Davenport (1945), in his studies of dietaries of primitive peoples, observes that nomadism is genetically determined and their dietary must needs be that of hunters. Utilization of various nutrients is under genetic control, i.e., vitamins are needed for production of enzymes which control cellular metabolism. There are inherited (genetic) differences in requirements of nutrients which have been studied by Dr. R. J. Williams and his associates (1950) who have observed genetic variations in nutrient requirements leading to development of genetotrophic disease and various behavior patterns even when on a seemingly adequate diet. Genetical defects of perception, color-blindness, and blindness in its several forms, odor perception, which is so variable, and hereditary defects described in detail by Bauer, Fischer, and Lenz (1927) (and in numerous other sources), are within the province of nutrition only as they affect food acceptance. The genetically controlled senses of taste, smell, sight, and touch had much to do with food acceptance in early times, i.e., good foods repulsive to us were life-sustaining to early man. Taboos and customs have altered our sensibilities. It was well that "cave men" were oblivious to stinks of putrefaction and fecal matter. World War I soldiers in the trenches of European battlefields never grew accustomed to the odors and environment. At least they never became anosmic (no sense of smell). Absent or defective taste genes are common among all peoples. A. L. Fox (1932) first observed that 30 per cent of people cannot taste phenylthiocarbamide; to others the chemical tastes bitter. Blakeslee (1932) and others found the characteristic to be an inherited Mendelian recessive factor. According to L. W. Parr (1934) and B. F. Lee (1934) this deficiency may have arisen in Caucasians and spread to other races through mixing. Some folk cannot perceive skunk odor; others cannot perceive the bitterness of quinine. Some families dislike sweets in any form (aglycophagia). In selecting taste panels, the great numbers of persons showing taste defects are astonishing. Hence, there is no accounting for tastes.

R. W. Moncrieff (1946) observes that biologically, the fundamental aims of animal life are self-preservation and preservation of species. One

can see how taste and smell serve these aims of primal man in hunting for food, in rejection of poisonous food, and in detection of, and escape from, enemies. In the human, the main influence of civilization on his chemical senses has been to blunt them. Taste and smell have lost their sharpness (some writers aver that certain cultivated foods may have lost their excellent pristine flavors).

We know that some scent experienced in childhood may afterwards, when perceived, awaken a forgotten memory. Whenever this scent is encountered again, the first memory of it comes back without conscious effort. This could be the case in primal man, who reacts in light of experience without conscious effort. Thoughts of favorite foods, like the smell of appetizing foods, start reflexes impossible to control (secretion of saliva and gastric juice).

It should not be concluded that environment has no effect on the gene. The influence of nutrition on constitutional traits is now well known. Genetic differences in enzyme patterns controlling the chemistry of the body may account for striking variations among individuals who are "normal." This genetotrophic concept may explain nutritional deficiencies on a good diet, and in early life plant the "time bomb" aspect of nutrition in the form of degenerative diseases in later maturity. Glass (1943) believes there is no sharp boundary between heredity and environment and that all characteristics of living organisms may be subdivided into genetic and environmental characteristics. Dr. W. C. Boyd (1950) points out the main evolutionary mechanisms possibly operating simultaneously: mixture, mutation, selection, and genetic drift. The relative importance of each may depend upon size of population. Finally, it may be assumed all human characteristics are inherited only in the sense that they are the result of action of certain genes (unknown at the present time) acting in a given nutritional and climatic environment. The shape of the nose, epicanthus folds, coloring of hair, eyes, and skin, as well as stature, are examples. The blood group genes appear not to be affected by climate, nutrition, or any known outside factors, and appear determined by heredity alone. Dr. W. C. Boyd (1950) has discussed in his interesting book, the use of blood group data in anthropological classification, to which we refer the reader for full information.

Man could have appeared in accordance with rules of Paleontological life, i.e., when a new group of animals appeared they did not originate from one pair of ancestors but from several ancestors. There are polyphyletic origins for nearly every domesticated plant and animal, and there is more than one wild species of dog, cattle, pig, sheep, chicken,

wheat, barley, grape, and apple. These species will cross and yield fertile or partially fertile hybrids. So Man may be and undoubtedly is of polyphyletic origin.

Clements, Martin, and Long (1950), discussing adaptation and origin in the plant world, conclude that adaptation is brought about by responses to direct physical factors, and is expressed both in functions and form. They believe it possible to convert one Linnaean species into another by altering the environment. Other observers, however, Clausen, Kick, and Hersey of Carnegie Institution of Washington (publ. 1940, 520), conclude that natural selection determines the character of plants in a given environment, and that the ability of a plant to adapt itself is dependent upon its genetical constitution. Changes produced by enviroment are never permanent, however spectacular they may appear.

As some paleontologists teach evolution, periods like 500,000 years are necessary for species evolution. One would be led to think that chromosome structures or gene changes require longer periods of time than are available for genetic experiments. According to this concept acquired characters, to be incorporated into heritage, must then be a matter of periods of time too great to be experimentally verified.

The distinguished zoologist, Adolph Portmann (1944), thinks that the peculiar position of man cannot be understood by a series of animal descents in the Darwinian sense, but only by "man's higher self law," *eigengesetzlichkeit*. When the three important periods, birth, puberty, and senescence are examined carefully, the first year after birth is a unique appearance in the domain of life. In puberty the peculiarity of human development is clearly shown. The process of aging in man is different from the same process in animals. Aside from foetal life, man can make himself in the sense which V. Gordon Childe (1948) so ably outlines in his popular work, "Man Makes Himself." Recently the geneticist, Dr. H. H. Strandskov (1950), concluded that man must accept his origin from some other species of primate and also his present biological status, but he need not accept completely his present evolutionary trend. It is within his power to redirect to some extent the present and future course of his own biologic evolution. The food drive and nutrition loom large in man's destiny from his beginnings to Valhalla.

In the light of the new physics we must postulate for life a universal field. There is not life and environment, but life *is* its environment. The conditions of life are a part of life, Professor J. E. Boodin (1934). Life does not stop with the boundaries of the skin. For instance, breathing and nutrition involve the whole field of the organism. There is mutual

interplay of such a complicated character, intelligible perhaps only in light of the autonomous field theory as developed by Gustaf Stromberg (1945), a natural consequence of modern wave mechanics and in harmony with recent discoveries in biology. Hence, we cannot partition life as partly belonging to heredity and partly to environment. Evolution of life is a creative response of the organism to the challenges of its environment. "Man can make himself" if he will, and if he willingly bends his stiff neck to God. Juvenal (130 A.D.), who needs only to be remembered for his Ideal, which has been famous ever since, wrote "*Mens sana in corpore sano*—A sound mind in a sound body."

It was Seneca who said: "Our forefathers have done much, but they have not finished anything." We shall likewise not finish things, but we can strive to make them better.

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